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RESEARCH MEMORANDUM

ANALYSIS OF V-G RECORDS FROM TEN TYPES OF NAVY AIRPLANES IN SQUADRON OPERATIONS DURING THE PERIOD 1949 TO 1953

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SUMMARY

An analysis of V-G records obtained during squadron operations with ten types of Navy airplanes is presented. Variations of normal load factor with speed are given for each airplane type in addition to the average flight time required to exceed a given normal load factor or indicated airspeed. In addition, the results are compared with a tentative standard probability curve for maneuvering normal load factors previously obtained from jet-fighter airplanes in which time-history instrumentation was used. In the range where comparisons are made, the results for both the fighter and bomber airplanes agree fairly well with the tentative standard curve and it is indicated that, by fitting the tentative standard curve to V-G data in the high-load-factor range, the approximate frequency of occurrence of low as well as high load factors may be estimated for use in fatigue analysis.

INTRODUCTION

V-G recorders have been used for many years as a means of checking maximum loads and airspeeds obtained on airplanes in flight. The records obtained have also been used to predict statistically the probability of occurrence or flight time required to reach design load factors and airspeeds.

The Bureau of Aeronautics, Department of the Navy, has supplied the National Advisory Committee for Aeronautics with V-G records obtained during squadron operations with several types of airplanes. An analysis of these records for several airplanes has been presented in references 1 and 2. The purpose of this paper is to present an analysis of the data for the remaining airplanes where the data were sufficient to warrant analysis. The data analyzed represent totals of 351 to 5660 hours of operations with ten types of Navy airplanes and were recorded during the period 1949 to 1953.

The data are presented as plots of maximum values of normal load factor attained against airspeed and of the average flight time required to exceed a given value of load factor or airspeed. In addition, the load-factor results are compared with a tentative standard maneuver probability curve to determine whether the results obtained at high load factors from V-G records might be used to determine the frequency of occurrence of low as well as high-load-factor peaks for possible use in fatigue analysis.

SYMBOLS

n	normal load factor
n_S	service-limit positive normal load factor
P	probability of exceeding a given load factor
p	activity factor, number of normal-load-factor peaks per hour of flying time which exceed 1g
V_i	indicated airspeed, knots
N	total number of observations for a particular quantity
t	flight time required, on the average, to exceed a given quantity
$\bar{n}$	average value of load-factor frequency distribution
$\bar{V}_i$	average value of maximum-indicated-airspeed frequency distribution, knots
α_{3_n}	coefficient of skewness of load-factor frequency distribution, $\frac{1}{\sigma_n^3}\frac{\sum(n-\bar{n})^3}{N}$
$\alpha_{3_{V_i}}$	coefficient of skewness of maximum-indicated-airspeed frequency distribution, $\frac{1}{\sigma_{V_i}^3}\frac{\sum(V_i-\bar{V}_i)^3}{N}$

σ_n standard deviation of load-factor frequency distribution, $\left[\frac{\sum(n - \bar{n})^2}{N}\right]^{1/2}$

σ_{V_i} standard deviation of airspeed frequency distribution, $\left[\frac{\sum(V_i - \bar{V}_i)^2}{N}\right]^{1/2}$

SCOPE AND EVALUATION OF DATA

V-G records were available for the following airplanes:

McDonnell F2H-2	Lockheed P2V-3
Grumman F9F-2B	Lockheed P2V-4
Lockheed TV-1(TO-1)	Martin P4M-1
Grumann F8F-2	Consolidated Vultee P4Y-2S
Douglas AD-4	Martin PBM-5S
North American AJ-1	

A list of the number of records evaluated, the number of hours of flight time, the service limit load factor, and the average gross weight for each airplane type is given in table I. The records were obtained in squadron operational training except for the Douglas AD-4 airplane for which 2936 hours were obtained during combat operations in the Korean area. V-G records which indicated evidences of unreliability were not evaluated and are not included in the totals of table I.

In order to illustrate the basic quantities derived from each record a typical record for the McDonnell F2H-2 airplane is shown in figure 1. The largest peak load factors occurring within various airspeed bands of 50 knots were tabulated. The peaks counted for a sample record of figure 1 are indicated with a symbol in figure 1. Similarly, the load-factor peaks were counted for the remainder of the records for the McDonnell F2H-2 airplane and the values within a given-airspeed and load-factor bracket are tabulated and totaled in table II. The same procedure was followed for the other airplanes and the results are presented in tables III to XIII. In some cases where more than one load-factor peak of similar magnitude occurred in the same speed range, all the peaks of similar magnitude were counted and are included in the tables. Values in these tables are given only for load factors greater than 1 or less than 0. In the lower part of each of these tables are given the average load factor $\bar{n}$, the standard deviation σ_n, and the

coefficient of skewness α_{z_n}. These are statistical parameters defining the distributions and are given for positive and negative load factors.

The maximum airspeed reached on each record was obtained and these were tabulated for each airplane in speed bands of 10 knots. These results along with their statistical parameters are tabulated in table XIV.

ANALYSIS AND RESULTS

V-n diagrams.- The peak values of load factor and speed read from the V-G records in the manner outlined previously are given in figures 2 to 11 for each of the airplanes along with the design operational V-n diagram for the weights listed in the figures. Only the highest and lowest points from the V-G records which serve to define an envelope are included in these figures, and the points shown are plotted at the midpoint of each speed band.

Flight time required to exceed a given quantity.- In addition to a knowledge of the largest loads obtained in flight, it would be desirable to obtain the frequency of occurrence of all load-factor peaks for use in fatigue analysis. It is obvious that a true count of the frequency of occurrence of load-factor peaks cannot be determined from V-G records unless the records are changed so often that the maximum values in each maneuver can be read. In practice, the maximums occurring in milder maneuvers tend to be covered up by those occurring in the more severe maneuvers until finally only the larger maximum values are outstanding on a given record. A count of these maximums on various records will approach the true frequency count at the higher values of load factor. Therefore, the average flight time required to exceed a given load factor derived from V-G records could only be expected to represent the true frequency count at the higher load-factor levels.

The range over which the frequency counts approach the true frequency curve is increased by having more records available for analysis for a given flight time and by counting more peaks per record. This point can be illustrated by reference to figures 12 and 13. In figure 12 the tentative standard probability curve for maneuvers from reference 3 is shown. This curve was obtained by counting all peak load factors greater than 1 obtained from time-history records with several jet-fighter airplanes in operational training. (It should be noted that in reference 3 a threshold of 0.25g was used so that load-factor peaks below 1.25g were not included in the frequency count.) A probability curve such as shown in figure 12 is one method

of characterizing the manner in which an airplane is utilized. Because it indicates the proportion of load-factor peaks which exceed a given load factor, it may be thought of as a measure of the severity of operations. Another measure of the manner in which an airplane is utilized is the average number of load-factor peaks per hour p, which is a measure of the activity of the operations. Time-to-exceed curves are a joint measure of both severity and activity since the probability curve determines the shape and the activity factor p, determines the level. The value of p is greatly influenced by the type of mission flown.

The time-to-exceed t in terms of the probability P (severity factor) and the activity factor p is

$$t = \frac{1}{Pp} \tag{1}$$

In figure 13, the lower curve was obtained from equation 1 by using the probability curve of figure 12 and represents the average flight time to exceed a given load factor for a jet fighter with an activity factor p equal to 40 peaks per hour greater than 1. This lower curve is derived from a true frequency count and thus correctly represents the time-to-exceed values over the entire load-factor range shown. This basic distribution was then broken down in order to simulate V-G records. The load-factor peaks were combined to form three hypothetical sets of V-G records representing 1920 hours of flight: one set consists of 10 records averaging 192 hours per record; one set of 100 records, averaging 19.2 hours per record; and the third set of 1000 records, averaging 1.92 hours per record. Each of these simulated sets of V-G records included all the load-factor peaks of the lower curve. It was then assumed that only the maximum load factor reached was read from each V-G record. It can be seen in figure 13 that the values of the time to exceed a given load factor obtained from each of the three sets of simulated V-G records approaches the values obtained from the true frequency distribution at the higher load factors and that the range of agreement is larger when the number of V-G records for a given flight time is increased.

In figures 14 to 24 the average flight time required to exceed a given positive and negative load factor regardless of the speed range is given for each airplane. The curves are shown only in the high-load-factor range. The closeness with which the data approach the true frequency curve such as shown in figure 13 cannot be established; however, the average number of hours represented by each V-G record varied from about 25 to 60 hours, and because several points were read from each record the curves shown are believed to be reasonably close to the true curve for the range shown in the figures. The tentative standard probability curve given in figure 12 was used with equation (1) to determine time-to-exceed curves for several values of the activity factor p

and these curves are also included in figures 14 to 24. In determining the time-to-exceed curves from the tentative standard curve, the values of the limit load factor given in table I were used. It was believed that, for the larger airplanes, most of the high load factors might be caused by gusts; therefore, approximate gust distributions were calculated for the North American AJ-1 and Consolidated Vultee P4Y-2S airplanes and are shown in figures 19 and 23. The gust curves shown were derived from the gust distribution for a transport airplane given in reference 4. When the distribution of reference 4 is used, it is assumed implicitly that the weather and operational history of the test airplanes are similar to those of the transport of reference 4, an assumption that is considered adequate for the purposes of this paper. Although the true gust distribution may vary from the curves shown in figures 19 and 23, the slopes of the curves should be approximately correct.

In figures 25 to 36 the average flight time required to exceed a given positive load factor in selected speed ranges is given, and in figures 37 to 47 the average time required to exceed a given maximum airspeed is presented. In all cases the experimental distributions were fitted with a Pearson type III curve to represent the data (ref. 5).

DISCUSSION OF RESULTS

V-n Envelopes

In general, it may be seen in figures 2 to 11 that all the airplanes reached the positive load-factor limits of the operational V-n diagram. In most cases the fighter-type airplanes exceeded the limit positive load factor. The limit load factor was exceeded by more than 2g with the F2H, TV-1, and F8F airplanes. (See figs. 2, 4, and 5.) The negative limit load factor was reached with the F2H-2 and the TV-1 airplanes. (See figs. 2 and 4.)

It may also be noted in figures 2 to 11 that most airplanes reached their maximum permissible airspeed. The maximum permissible airspeed was appreciably exceeded with the AD-4 airplane (fig. 6) in training but not in combat.

Flight Time Required to Exceed a Given Load Factor

Fighter-type airplanes.- It may be seen in figures 14, 15, and 16 that the time-to-exceed curves derived from the tentative standard probability curve appear to fit the data for the jet-fighter airplanes fairly well although the frequency of maneuvers appears to be less than that found in reference 3. In reference 3 it was found that the number of load-factor peaks greater than 1 varied from about 20 to 60 per hour for normal USAF operational training with jet-fighter airplanes. The

frequency of occurrence of load factors greater than 1 (1.25) for the F2H-2, F9F-2B, and TV-1 airplanes appears to be between 2 and 5 load-factor peaks per hour.

In figures 17 and 18 it may be seen that the tentative standard probability curve for jet fighters does not appear to be applicable for the F8F-2 and AD-4 propeller-driven airplanes because the slopes of the time-to-exceed curves are different. There are two possible reasons for this difference. First, the probability of exceeding a given load factor may be different for propeller-driven fighters than for jet-fighter airplanes because of the method of utilization. On the other hand, because the tentative standard curve shown in figures 17 and 18 are based on the service limit load factor, they will be different for different service limit load factors. If the F8F-2 and AD-4 airplanes were flown as if the service limit load factor were about 7.5 to 8, the standard curves would approximate the data fairly well for a frequency value between 1 and 2 load-factor peaks per hour.

In all the comparisons of the tentative standard curve with the test data the standard curves shown are given for limit load factors which do not necessarily correspond to the average gross weights as listed in table I. The limit load factors used are those which are usually given in pilots' handbooks and are consistent with the manner in which the tentative standard curve was originally derived. Since the airplane weights varied somewhat during the recording period, it is possible that the higher load factors measured were associated with the lower gross weights rather than with the average gross weights.

For the AD-4 airplane, both combat and training data are available. It may be seen in figure 18 that, for positive load factors, the average flight time required to exceed a given load factor in training operations appears to be somewhat less than in combat operations whereas for negative load factors the opposite is true. The difference between the positive values probably is not significant (of the order of 2 to 1); however, it may be noted in table I that the operating weight was considerably higher in combat than in training.

Large airplanes.- The time-to-exceed curves derived from the tentative standard probability curve for jet-fighter training are also plotted for the larger airplanes such as the patrol bombers. (See figs. 19 to 24.) The standard curves are given for three values of the activity factor. The values shown are for 1 maneuver in 10 hours ($p = 0.1$), 1 maneuver in 2 hours, ($p = 0.5$), and 1 maneuver in 1 hour ($p = 1.0$). The tentative standard curve obtained from jet-fighter training appears to fit most of the large airplane data fairly well.

It may be seen that the slope of the gust curve for the AJ-1 airplane in figure 19 is much greater than that for the test data; whereas,

in figure 23 for the P4Y airplane, the slope of the gust curve is only slightly greater than that for the test data. It is indicated, therefore, that for the AJ-1 and P2V airplanes the high load factors are obtained in maneuvers whereas for the other large airplanes (P4Y, P4M, PBM) the highest load factors may be due to both gusts and maneuvers. The fact that the tentative standard maneuver curve appears to fit the data for these cases may or may not be coincidental since the shape of the gust and maneuver curves is somewhat similar at the highest load factors. If it is assumed that the high load factors are obtained in maneuvers, however, it appears that the maneuver frequency is between one maneuver in 2 hours and 1 maneuver in 10 hours for the large airplanes.

When the results for the fighter-type airplanes are compared with the result obtained with larger airplanes (figs. 14 to 24), it is seen that the fighter-type airplanes exceed their limit load factor in from 70 to 400 hours whereas most larger airplanes will exceed their limit load factor, on the average, in much more than 1000 hours. The data for the P2V-3 airplane, however, indicate an average time to exceed the limit load factor of only 200 hours. (See fig. 20.) A possible reason for this result may be that the P2V-3 data included a greater proportion of gunnery training than did the data for the P2V-4.

None of the time-to-exceed curves given in this paper are extended beyond the test data. The curves were not extrapolated since it is believed that the distribution of loads may be affected at higher load factors by inadvertent maneuvers. In reference 3 it was shown that reversals in time-to-exceed curves, such as noted in some experimental data, might occur because of the addition of two frequency distributions of load factor; one distribution being the normal-maneuver distribution and the other distribution being the one associated with inadvertences or emergencies. This reversal might cause the value of the time to exceed a given load factor extrapolated from data obtained at lower load factors to be highly unconservative.

Distribution of load factors in given airspeed ranges.- The curves showing the average flight time required to exceed a given load factor in a given speed range (that is, figs. 25 to 36) are based on the total flight time at all airspeeds because the time spent in each speed range cannot be determined from V-G records. Of course, the average flight time in a given airspeed range required to exceed a given load factor based on flight time spent in that airspeed range may be considerably different. From the figures of flight time required to exceed a given load factor in a given airspeed range, it is indicated that the time-to-exceed curves are influenced considerably by the stall curve of the V-n diagram. It may be seen that, as the speed increases and the load factor for maximum lift increases, the curves shift toward the higher load factors until the upper left-hand corner of the V-n diagram is reached. At the highest airspeeds for some of the fighter-type airplanes (see

figs. 25 and 26) an increased probability of occurrence of a given load factor is indicated by the decreased slope of the time-to-exceed curves. The actual time-to-exceed values may be considerably greater than those for lower speeds, however, because of the small percentage of flight time spent at the highest speeds. Although not shown in this paper, the time-to-exceed curves of figures 25 to 36 could be used to estimate load-factor airspeed envelopes for a given number of flight hours.

Maximum airspeeds.- The operational maximum permissible airspeeds were reached for most of the airplanes during the period of these tests (figs. 37 to 47). The average time required to exceed the operational limit airspeed was low (less than 200 hours) for the F9F-2B, AD-4 (training), and P2V-3 airplanes. On the other hand, the average flight time required to exceed the operational limit airspeed for the TV-1, AJ-1, P2V-4, P4M-1, and PBM-5S airplanes was considerably more than that for the other airplanes (greater than 700 hours).

The flight time required to exceed a given value of airspeed in combat for the AD-4 is about 10 times that for training operations. (See fig. 41.) The reason for this difference may be due to the different speed restrictions when external stores are carried; the maximum permissible speed for the AD-4 airplane is 350 knots with external fuel tanks and 410 knots without external tanks.

CONCLUDING REMARKS

An analysis of V-G records obtained during squadron operations with ten types of Navy airplanes has been presented. The data indicate that the fighter-type airplanes would exceed their limit load factor in from 70 to 400 hours whereas most of the larger airplanes would exceed their limit load factor in many more than 1000 hours. The data of this paper have not been extrapolated to the ultimate load factor because it is believed that the statistical extrapolation based on data obtained at lower load factors may be highly unconservative because of an emergency or inadvertency load-factor distribution superimposed on the ordinary distribution.

A tentative standard maneuver probability curve for jet-fighter-airplane training was compared with the results from the V-G recorders at high load factor and it was found that the tentative standard curve appears to be applicable to the jet-fighter-type airplanes and also to the bomber-type airplanes considered. It is indicated that, by fitting the tentative standard curve to V-G data in the high load-factor range, the approximate frequency of occurrence of low as well as high load factors may be estimated for use in fatigue analysis. The number of load-factor peaks per hour greater than 1 g appeared to be from about 2 to 5 for the jet fighters; this value is smaller than the 20 to 60

peaks obtained in other tests. For the larger airplanes, the number of maneuvers per hour appeared to vary between 0.1 and 0.5.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., July 2, 1954.

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TABLE I.- AIRPLANES AND DATA

Airplane	Type	Average gross weight	Number of records	Number of hours	n_s (1)	Recording date
McDonnell F2H-2	Jet fighter	18,100	134	5444	6.40	June 1950 to June 1952
Grumman F9F-2B	Jet fighter	15,500	30	1370	7.50	Oct. 1949 to Feb. 1951
Lockheed TV-1	Jet trainer	12,300	174	5660	7.33	Feb. 1951 to April 1952
Grumman F8F-2	Propeller-driven fighter	10,500	41	1092	6.30	July 1949 to Nov. 1949
Douglas AD-4	Attack bomber	14,700	61	1552 (Training)	7.00	May 1950 to Aug. 1950
Douglas AD-4	Attack bomber	18,300	51	2936 (Combat)	7.00	Aug. 1950 to Feb. 1951
North American AJ-1	Attack bomber	39,000	14	351	4.00	Feb. 1952 to July 1953
Lockheed P2V-3	Patrol bomber	58,000	15	470	2.60	April 1950 to July 1950
Lockheed P2V-4	Patrol bomber	64,000	23	1441	2.77	Nov. 1951 to Nov. 1952
Martin P4M-1	Patrol bomber	75,000	28	916	2.80	March 1952 to Aug. 1952
Consolidated Vultee P4Y-2S	Patrol bomber	58,000	64	2078	2.50	Aug. 1951 to Dec. 1951
Martin PBM-5S	Flying boat	52,000	24	1072	2.60	July 1951 to Feb. 1952

[1]Values are given for the gross weights indicated in figures 2 to 11 and are those usually given in the pilots' handbooks

TABLE II.- LOAD-FACTOR FREQUENCY DISTRIBUTION - MCDONNELL F2H-2 AIRPLANE

n	Frequency of occurrence for V_i of -																	
	150 to 200		200 to 250		250 to 300		300 to 350		350 to 400		400 to 450		450 to 500		500 to 550		Total	
-3.0 to -3.5									1								1	
-2.5 to -3.0							1		1		1		1				4	
-2.0 to -2.5							2		0		0		0				2	
-1.5 to -2.0					2		4		3		1		3				13	
-1.0 to -1.5					4		6		3		4		1				18	
-0.5 to -1.0	2		10		29		44		36		25		5				151	
0 to -0.5	5		21		44		61		54		33		15		1		234	
1.0 to 1.5	3		1		0		0		1		5		9		3		22	
1.5 to 2.0	21		0		1		0		0		5		19		4		50	
2.0 to 2.5	33		6		0		2		3		10		26		2		82	
2.5 to 3.0	52		24		5		8		6		20		20		0		135	
3.0 to 3.5	8		44		16		7		12		24		14		2		127	
3.5 to 4.0			44		28		14		17		31		13		1		148	
4.0 to 4.5			14		62		36		35		45		9		0		201	
4.5 to 5.0			4		29		63		57		28		9		1		191	
5.0 to 5.5					23		41		36		12		4		1		117	
5.5 to 6.0					6		28		28		12		6				80	
6.0 to 6.5							7		13		5		0				25	
6.5 to 7.0							4		9		2		0				15	
7.0 to 7.5									3		2		0				5	
7.5 to 8.0									0		0		2				2	
8.0 to 8.5									1		1		0				2	
8.5 to 9.0													1				1	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
N	117	7	137	31	170	79	210	118	221	98	202	64	132	25	14	1	1203	423
$\bar{n}$	2.425	–	3.411	--	4.288	0.522	4.767	0.593	4.836	0.566	4.012	0.570	3.129	0.670	2.536	–	4.002	0.557
σ_n	0.468	–	0.582	--	0.703	0.354	0.854	0.473	1.041	0.497	1.207	0.436	1.416	0.658	1.287	–	1.251	0.454
α_{3_n}	0.436	–	-0.257	--	-0.250	1.342	-0.430	1.988	0.094	2.844	0.195	2.316	1.194	1.662	0.885	–	0.037	2.374

TABLE III.- LOAD-FACTOR FREQUENCY DISTRIBUTION - GRUMMAN F9F-2B AIRPLANE

n	Frequency of occurrence for V_i of -																	
	150 to 200		200 to 250		250 to 300		300 to 350		350 to 400		400 to 450		450 to 500		500 to 550		Total	
-1.5 to -2.0													1				1	
-1.0 to -1.5													0				0	
-.5 to -1.0			1		2		4		6		5		2				20	
0 to -.5	2		3		9		15		14		16		6				65	
1.0 to 1.5	3		1		0		0		0		0		2		0		6	
1.5 to 2.0	5		0		0		0		0		1		0		3		9	
2.0 to 2.5	9		1		0		0		1		0		3		3		17	
2.5 to 3.0	12		5		3		4		0		1		2		1		28	
3.0 to 3.5			6		1		1		1		0		2		0		11	
3.5 to 4.0			14		2		1		2		4		2		1		26	
4.0 to 4.5					9		3		4		6		4		1		27	
4.5 to 5.0					13		4		3		6		5		0		31	
5.0 to 5.5					4		13		8		8		11		1		45	
5.5 to 6.0							9		15		7		1		0		32	
6.0 to 6.5							2		5		4		3		1		15	
6.5 to 7.0							1		1		2		1				5	
7.0 to 7.5									3		3		0				6	
7.5 to 8.0									1				2				3	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
N	29	2	27	4	32	11	38	19	44	20	42	21	38	9	11	0	261	86
$\bar{n}$	2.267	-	3.306	-	4.375	--	4.974	--	5.454	--	5.143	--	4.579	0.528	3.114	-	4.400	0.383
σ_n	0.500	-	0.598	-	0.685	--	1.011	--	1.062	--	1.162	--	1.540	0.478	1.479	-	1.464	0.258
α_{3_n}	-0.691	-	-0.164	-	-0.015	--	-1.038	--	0.514	--	-0.376	--	-0.255	0.123	0.921	-	-0.187	1.068

TABLE IV.- LOAD-FACTOR FREQUENCY DISTRIBUTION - LOCKHEED TV-1 AIRPLANE

n	Frequency of occurrence for V_i of -																	
	150 to 200		200 to 250		250 to 300		300 to 350		350 to 400		400 to 450		450 to 500		500 to 550		Total	
-3.0 to -3.5							1										1	
-2.5 to -3.0			1		1		0										2	
-2.0 to -2.5	1		2		2		0		1								6	
-1.5 to -2.0	5		6		6		6		0		1						24	
-1.0 to -1.5	7		16		13		6		8		3						53	
-.5 to -1.0	14		41		59		37		22		10		3				186	
0 to -.5	29		49		74		68		52		12		1				285	
1.0 to 1.5	3		1		1		1		1		15		3		0		25	
1.5 to 2.0	6		0		0		0		4		26		10		1		47	
2.0 to 2.5	15		3		0		1		10		31		6		2		68	
2.5 to 3.0	28		3		3		3		14		29		10		0		90	
3.0 to 3.5	21		13		1		2		34		34		5		1		111	
3.5 to 4.0	32		51		12		16		40		24		6				181	
4.0 to 4.5	13		49		46		49		38		20		3				218	
4.5 to 5.0	15		41		60		59		49		11		3				238	
5.0 to 5.5			14		61		49		25		9						158	
5.5 to 6.0			7		45		41		17		2						112	
6.0 to 6.5			7		14		36		7		0						64	
6.5 to 7.0					9		13		3		1						26	
7.0 to 7.5					3		7		5								15	
7.5 to 8.0					4		4		2								10	
8.0 to 8.5					2		0		1								3	
8.5 to 9.0							0		1								1	
9.0 to 9.5							0		0								0	
9.5 to 10.0							1		2								3	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
N	133	56	189	115	261	155	282	118	253	83	202	26	46	4	4	0	1370	557
$\bar{n}$	3.306	0.830	4.287	0.798	5.114	0.624	5.191	0.559	4.369	0.503	3.054	0.615	2.783	—	—	—	4.313	0.613
σ_n	0.875	0.533	0.801	0.515	0.923	0.467	1.030	0.474	1.310	0.383	1.136	0.406	0.980	—	—	—	1.337	0.475
α_{3_n}	-0.139	1.134	0.049	1.338	0.336	1.865	0.269	2.381	0.859	1.746	0.400	1.304	0.359	—	—	—	0.076	1.676

TABLE V.- LOAD-FACTOR FREQUENCY DISTRIBUTION - GRUMMAN F8F-2 AIRPLANE

n	Frequency of occurrence for V_i of -															
	100 to 150		150 to 200		200 to 250		250 to 300		300 to 350		350 to 400		400 to 450		Total	
-1.0 to -1.5			1		2		1								4	
-.5 to -1.0	2		3		4		3		1						13	
0 to -.5	4		7		11		7		3						32	
1.0 to 1.5	2		1		0		2		6		5		1		17	
1.5 to 2.0	7		1		0		2		4		6		1		21	
2.0 to 2.5	4		4		0		0		3		2		0		13	
2.5 to 3.0	9		9		6		1		5		4		0		34	
3.0 to 3.5			8		7		6		2		3		1		27	
3.5 to 4.0			14		10		8		2		2				36	
4.0 to 4.5					12		4		5		2				23	
4.5 to 5.0					9		15		12		2				38	
5.0 to 5.5					4		3		2		7				16	
5.5 to 6.0					3		11		8		3				25	
6.0 to 6.5							3		0		0				3	
6.5 to 7.0							3		0		0				3	
7.0 to 7.5							0		1		2				3	
7.5 to 8.0							0		0		1				1	
8.0 to 8.5							0		0						0	
8.5 to 9.0							1		1						2	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
N	22	6	37	11	51	17	59	11	51	4	39	0	3	0	262	49
$\bar{n}$	2.204	-	3.115	--	4.093	--	4.631	--	3.917	-	3.686	-	-	-	3.800	--
σ_n	0.520	-	0.644	--	0.825	--	1.394	--	1.723	-	1.861	-	-	-	1.498	--
α_{3_n}	-0.302	-	1.585	--	0.115	--	-1.632	--	0.131	-	0.351	-	-	-	0.299	--

TABLE VI.- LOAD-FACTOR FREQUENCY DISTRIBUTION - DOUGLAS AD-4 AIRPLANE (COMBAT)

n	Frequency of occurrence for V_i of -													
	100 to 150		150 to 200		200 to 250		250 to 300		300 to 350		350 to 400		Total	
-2.0 to -2.5							1						1	
-1.5 to -2.0							2		4				6	
-1.0 to -1.5			1		1		3		2				7	
-.5 to -1.0	1		2		2		10		5		1		21	
0 to -.5	0		2		8		7		6		2		25	
1.0 to 1.5	8		2		1		2		5		4		22	
1.5 to 2.0	24		0		0		0		1		1		26	
2.0 to 2.5	8		2		0		0		0		0		10	
2.5 to 3.0	7		15		1		0		1		1		25	
3.0 to 3.5	3		18		3		0		0		3		27	
3.5 to 4.0			12		6		6		11		6		41	
4.0 to 4.5			6		12		1		4		5		28	
4.5 to 5.0					13		11		7		6		37	
5.0 to 5.5					12		9		13		0		34	
5.5 to 6.0					8		15		22		4		49	
6.0 to 6.5					1		8		7		3		19	
6.5 to 7.0					1		8		11		0		20	
7.0 to 7.5							1		2		0		3	
7.5 to 8.0							3		6		1		10	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-
N	50	1	55	5	58	11	64	23	90	17	34	3	351	60
$\bar{n}$	1.980	—	3.223	—	4.672	--	5.460	--	5.289	--	4.147	—	4.313	0.725
σ_n	0.550	—	0.643	—	0.918	--	1.243	--	1.533	--	1.566	—	1.685	0.520
α_{3_n}	0.441	—	-0.721	—	-0.806	--	-1.167	--	-0.889	--	-0.187	—	-0.123	0.990

TABLE VII.- LOAD-FACTOR FREQUENCY DISTRIBUTION - DOUGLAS AD-4 AIRPLANE (TRAINING)

n	Frequency of occurrence for V_i of -																	
	100 to 150		150 to 200		200 to 250		250 to 300		300 to 350		350 to 400		400 to 450		450 to 500		Total	
-0.5 to -1.0					1		1		3								5	
0 to -.5					2		2		0		1						5	
1.0 to 1.5	6		5		4		3		5		4		3		1		31	
1.5 to 2.0	13		5		0		0		0		1		0		0		19	
2.0 to 2.5	13		6		2		1		1		1		0		0		24	
2.5 to 3.0	14		28		7		4		3		1		0		0		57	
3.0 to 3.5	3		6		6		5		5		0		1		0		26	
3.5 to 4.0	1		14		17		5		8		1		0		0		46	
4.0 to 4.5			2		14		12		8		2		0		0		38	
4.5 to 5.0			1		12		8		10		5		2		0		38	
5.0 to 5.5					4		8		5		3		0		0		20	
5.5 to 6.0							10		9		2		4		1		26	
6.0 to 6.5							4		4		5		1				14	
6.5 to 7.0							11		8		13		1				33	
7.0 to 7.5							1		5		2		2				10	
7.5 to 8.0									2		5		2				9	
8.0 to 8.5									2								2	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
N	50	0	67	0	66	3	72	3	75	3	45	1	16	-	2	0	393	10
$\bar{n}$	2.230	-	2.847	-	3.780	-	4.819	-	4.885	-	5.495	-	5.156	-	-	-	4.084	--
σ_n	0.599	-	0.783	-	0.973	-	1.439	-	1.693	-	1.934	-	2.195	-	-	-	1.770	--
α_{3_n}	-0.054	-	-0.160	-	0.913	-	0.188	-	0.289	-	0.246	-	0.747	-	-	-	0.273	--

TABLE VIII.- LOAD-FACTOR FREQUENCY DISTRIBUTION - NORTH AMERICAN AJ-1 AIRPLANE

n	Frequency of occurrence for V_i of -																							
	125 to 150		150 to 175		175 to 200		200 to 225		225 to 250		250 to 275		275 to 300		300 to 325		325 to 350		350 to 375		Total	
-0.25 to -0.50					1																1			
0 to -.25					0												1		1		2			
1.00 to 1.25	1		0		0		0		0		0		1		1		0		0		3			
1.25 to 1.50	6		2		1		0		1		2		3		1		1		0		17			
1.50 to 1.75	6		4		3		3		5		2		2		3		2		1		31			
1.75 to 2.00	1		4		2		5		3		3		0		1		1		1		21			
2.00 to 2.25			3		6		3		2		1		2		2		1				20			
2.25 to 2.50			1		3		3		2		1		2		0						12			
2.50 to 2.75									3		1		1		1						6			
2.75 to 3.00									1		0		0								1			
3.00 to 3.25											0		0								0			
3.25 to 3.50											2		1								3			
3.50 to 3.75											1										1			
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
N	14	0	14	0	15	1	14	0	17	0	13	0	12	0	9	0	5	1	2	1	115	3		
$\bar{n}$	1.500	–	1.821	–	1.992	–	1.982	–	2.052	–	2.240	–	1.983	–	1.792	–	1.725	–	–	–	1.912	–		
σ_n	0.183	–	0.286	–	0.301	–	0.263	–	0.444	–	0.751	–	0.632	–	0.425	–	0.255	–	–	–	0.477	–		
α_{3_n}	0	–	0.140	–	0.495	–	0.189	–	0.681	–	-0.410	–	0.676	–	0.392	–	0.460	–	–	–	1.126	–		

TABLE IX.- LOAD-FACTOR FREQUENCY DISTRIBUTION - LOCKHEED P2V-3 AIRPLANE

n	Frequency of occurrence for V_i of -																	
	100 to 125		125 to 150		150 to 175		175 to 200		200 to 225		225 to 250		250 to 275		275 to 300		Total	
1.00 to 1.25	1		1		1		1		3		2		0		1		10	
1.25 to 1.50			7		5		3		1		1		1		0		18	
1.50 to 1.75			5		6		5		2		3		1		0		22	
1.75 to 2.00			2		4		4		5		3		2		1		21	
2.00 to 2.25							2		3		3		0		1		9	
2.25 to 2.50									1				1		0		2	
2.50 to 2.75													2		1		3	
2.75 to 3.00															3		3	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
N	1	0	15	0	16	0	15	0	15	0	12	0	7	0	7	0	88	0
$\bar{n}$	—	—	1.508	—	1.578	—	1.675	—	1.742	—	1.708	—	2.054	—	2.425	—	1.722	—
σ_n	—	—	0.201	—	0.225	—	0.277	—	0.386	—	0.344	—	0.457	—	0.619	—	0.415	—
α_{3_n}	—	—	0.274	—	-0.162	—	-0.106	—	-0.590	—	-0.421	—	0.057	—	0.854	—	0.816	—

TABLE X.- LOAD-FACTOR FREQUENCY DISTRIBUTION - LOCKHEED P2V-4 AIRPLANE

n	Frequency of occurrence for V_i of -																	
	100 to 125		125 to 150		150 to 175		175 to 200		200 to 225		225 to 250		250 to 275		275 to 300		Total	
1.00 to 1.25	1		4		1		1		2		3		2		1		15	
1.25 to 1.50	1		12		12		7		6		5		4		0		47	
1.50 to 1.75			3		7		10		10		3		2		1		36	
1.75 to 2.00			2		2		1		2		3		1		0		11	
2.00 to 2.25					1		3		3		2		2		1		12	
2.25 to 2.50											1		1		1		3	
2.50 to 2.75													1				1	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
N	2	0	21	0	23	0	22	0	23	0	17	0	13	0	4	0	125	0
$\bar{n}$	—	—	1.411	—	1.516	—	1.602	—	1.603	—	1.610	—	1.702	—	1.813	—	1.567	—
σ_n	—	—	0.208	—	0.219	—	0.260	—	0.275	—	0.369	—	0.464	—	0.480	—	0.318	—
α_{3_n}	—	—	0.716	—	0.965	—	0.666	—	0.369	—	0.432	—	0.557	—	0.278	—	0.881	—

TABLE XI.- LOAD-FACTOR FREQUENCY DISTRIBUTION - MARTIN P4M-1 AIRPLANE

n	Frequency of occurrence for V_i of -																			
	100 to 125		125 to 150		150 to 175		175 to 200		200 to 225		225 to 250		250 to 275		275 to 300		300 to 325		Total	
1.00 to 1.25	1		2		0		1		3		9		8		4		2		30	
1.25 to 1.50	21		9		11		5		15		18		9		9		0		97	
1.50 to 1.75	2		17		14		17		11		7		8		4		0		80	
1.75 to 2.00			1		7		8		3		2		1		4		0		26	
2.00 to 2.25							3		0		2		0				1		6	
2.25 to 2.50							0		1				1						2	
2.50 to 2.75							1												1	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
N	24	0	29	0	32	0	35	0	33	0	38	0	27	0	21	0	3	0	242	0
$\bar{n}$	--	-	1.487	-	1.594	-	1.704	-	1.511	-	1.428	-	1.431	-	1.470	-	-	-	1.512	-
σ_n	--	-	0.168	-	0.185	-	0.272	-	0.247	-	0.258	-	0.283	-	0.250	-	-	-	0.255	-
α_{3_n}	--	-	-0.659	-	0.222	-	0.944	-	1.195	-	1.016	-	1.237	-	1.529	-	-	-	-0.846	-

TABLE XII.- LOAD-FACTOR FREQUENCY DISTRIBUTION - CONSOLIDATED VULTEE P4Y-2S AIRPLANE

n	Frequency of occurrence for V_i of -																							
	75 to 100		100 to 125		125 to 150		150 to 175		175 to 200		200 to 225		225 to 250		250 to 275		275 to 300		300 to 325		325 to 350		Total	
-0.25 to 0			1						1														2	
1.00 to 1.25	32		27		23		17		18		14		2		1		2		1				137	
1.25 to 1.50	25		27		35		28		26		10		1		2		0		1		2		157	
1.50 to 1.75	8		5		8		14		15		4						1		1				56	
1.75 to 2.00			4		1		6		3		1												15	
2.00 to 2.25			5				1																6	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
N	65	0	68	1	67	0	66	0	62	1	29	0	3	0	3	0	3	0	3	0	2	0	371	2
$\bar{n}$	--	-	1.379	-	1.327	-	1.421	-	1.387	-	1.306	-	-	-	-	-	-	-	-	-	-	-	1.353	-
σ_n	--	-	0.292	-	0.174	-	0.242	-	0.213	-	0.207	-	-	-	-	-	-	-	-	-	-	-	0.226	-
α_{3_n}	--	-	1.296	-	0.548	-	0.633	-	0.380	-	0.916	-	-	-	-	-	-	-	-	-	-	-	1.025	-

TABLE XIII.- LOAD-FACTOR FREQUENCY DISTRIBUTION - MARTIN PBM-5S AIRPLANE

n	Frequency of occurrence for V_i of -									
	125 to 150		150 to 175		175 to 200		200 to 225		Total	
-0.25 to 0	2		1						3	
1.00 to 1.25	2		4		3		2		11	
1.25 to 1.50	12		13		7		0		32	
1.50 to 1.75	9		5		2		1		17	
1.75 to 2.00	1		1		1				3	
	+	-	+	-	+	-	+	-	+	-
N	24	2	23	1	13	0	3	0	63	3
$\bar{n}$	1.469	—	1.408	—	1.394	—	—	—	1.423	—
σ_n	0.174	—	0.185	—	0.207	—	—	—	0.193	—
α_{3_n}	0.081	—	0.430	—	0.668	—	—	—	0.027	—

TABLE XIV.- FREQUENCY DISTRIBUTION OF MAXIMUM INDICATED AIRSPEEDS

V_i	Frequency distribution of indicated airspeeds of airplane -											
	F2H-2	F9F-2B	TV-1	F8F-2	AD-4 combat	AD-4 training	AJ-1	P2V-3	P2V-4	P4M-1	P4Y-2S	PBM-5S
100 to 110											1	
110 to 120											1	
120 to 130											0	
130 to 140												
140 to 150											1	
150 to 160											1	2
160 to 170											0	4
170 to 180											2	8
180 to 190											9	4
190 to 200											12	3
200 to 210								1		1	18	1
210 to 220								0	1	0	12	1
220 to 230								2	4	0	7	1
230 to 240							1	3	5	1		
240 to 250							0	0	0	0		
250 to 260							0	3	2	5		
260 to 270							1	0	5	2		
270 to 280				1		1	1	2	1	3		
280 to 290				0	1	1	0	1	3	9		
290 to 300				0	0	0	1	1	1	2		
300 to 310				3	0	2	1	2	1	2		
310 to 320				2	4	5	2			2		
320 to 330	1			1	4	7	2			1		
330 to 340	0			5	3	4	3					
340 to 350	0			2	9	2	1					
350 to 360	0			4	7	7	1					
360 to 370	0			3	6	3						
370 to 380	0		3	8	9	7						
380 to 390	1		4	2	3	3						
390 to 400	1		12	2	3	4						
400 to 410	1		19	6	2	7						
410 to 420	5		22	1		1						
420 to 430	6	1	26	1		0						
430 to 440	7	1	20			1						
440 to 450	6	0	30			0						
450 to 460	14	2	13			5						
460 to 470	14	3	8			1						
470 to 480	28	4	9									
480 to 490	19	1	2									
490 to 500	13	4	2									
500 to 510	11	7	3									
510 to 520	3	5	1									
520 to 530	3	2										
530 to 540	0											
540 to 550	1											
550 to 560												
N	134	30	174	41	51	61	14	15	23	28	64	24
$\bar{V}_i$	469.00	484.700	432.300	362.300	355.900	367.500	311.400	257.700	255.400	278.200	199.10	180.800
σ_{V_i}	30.40	25.600	27.400	34.900	25.700	45.200	32.400	30.200	25.400	25.100	21.30	17.100
α_{3V_i}	-1.00	-0.749	0.436	-0.365	0.172	0.337	-0.911	0.106	0.238	0.651	-1.82	0.815

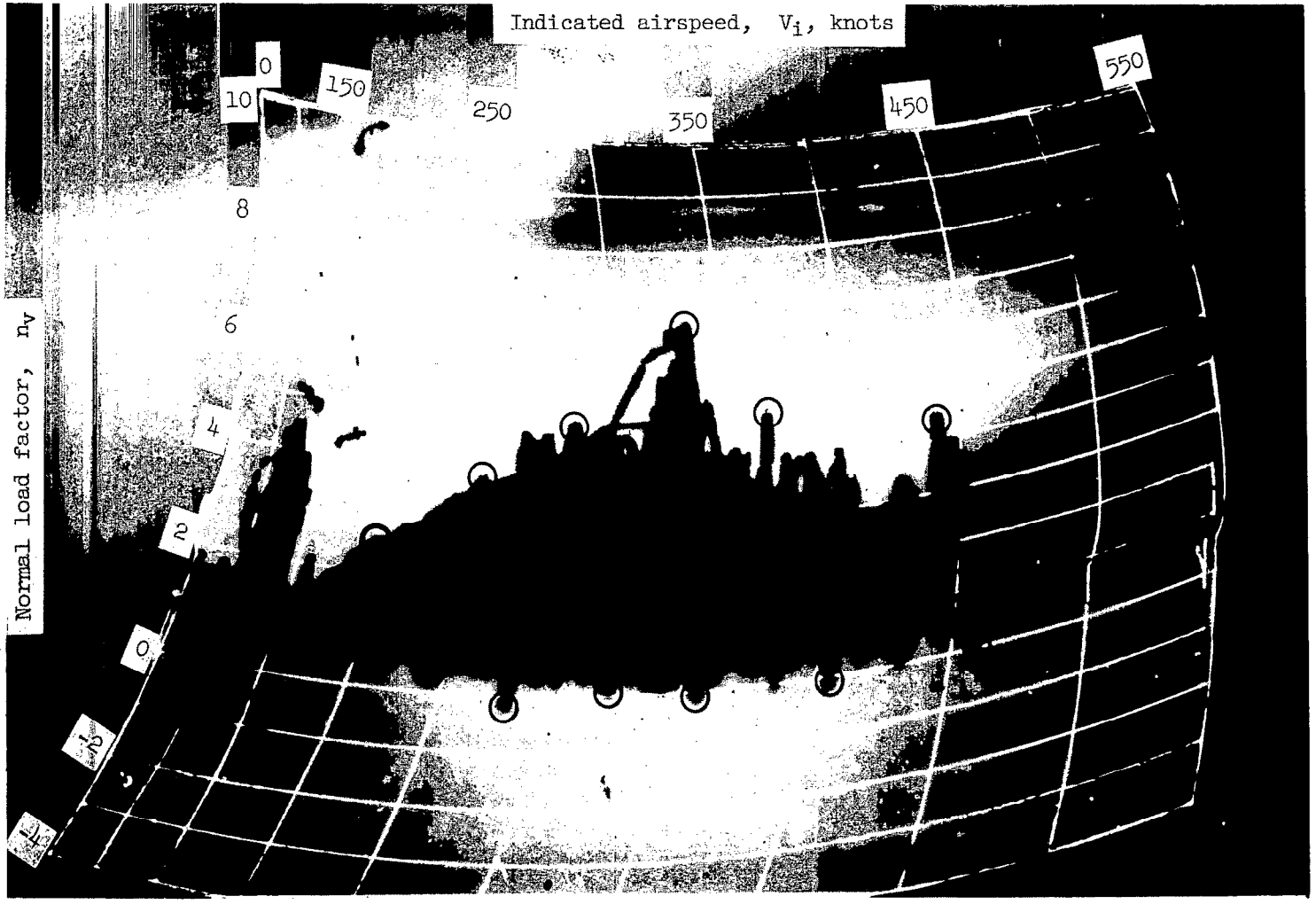

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Figure 1.- A typical V-G record for the McDonnell F2H-2 airplane showing quantities read.

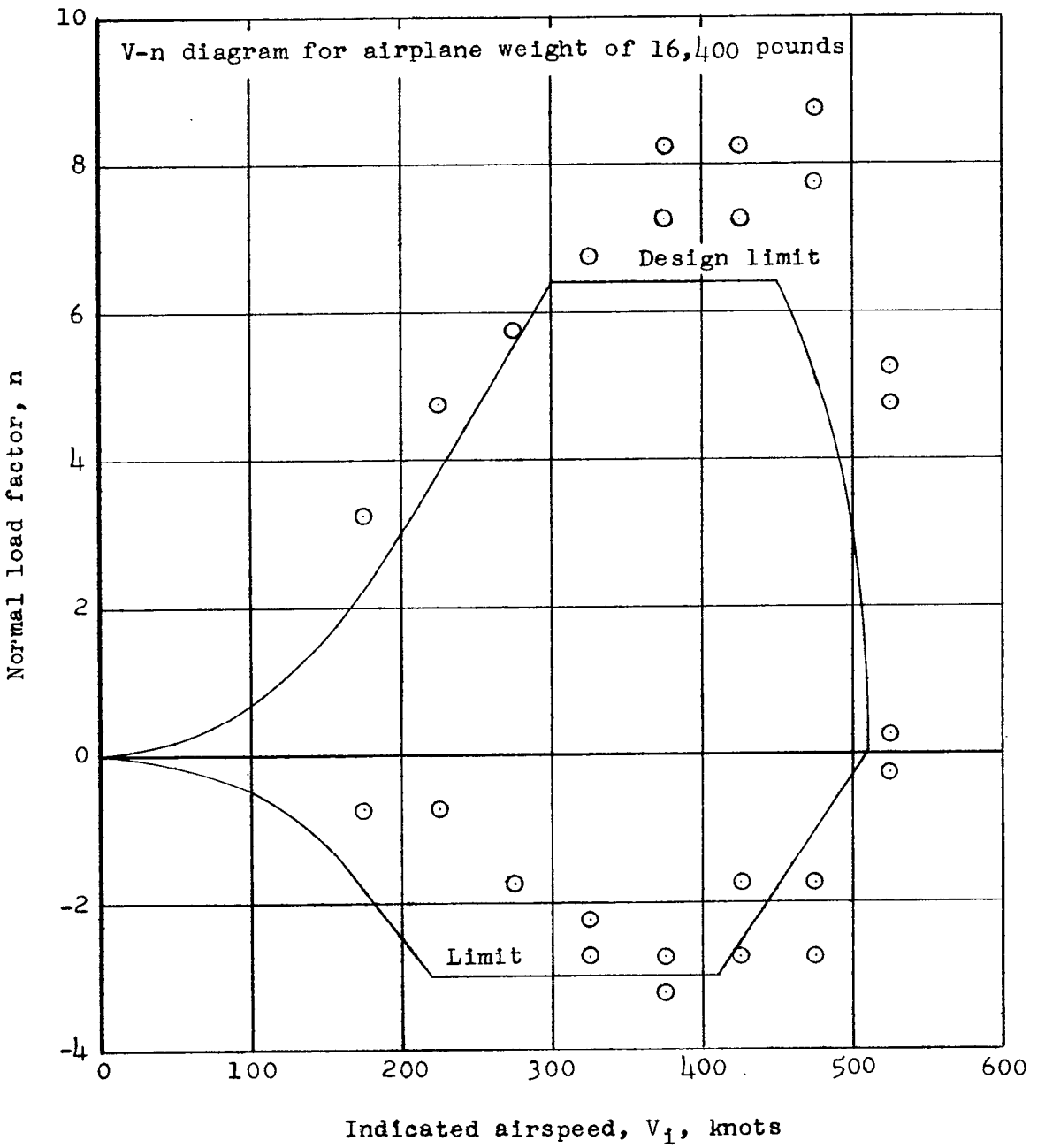

Figure 2.- Comparison of experimental load-factor peaks with operational V-n diagram. McDonnell F2H-2 airplane (5444 hours).

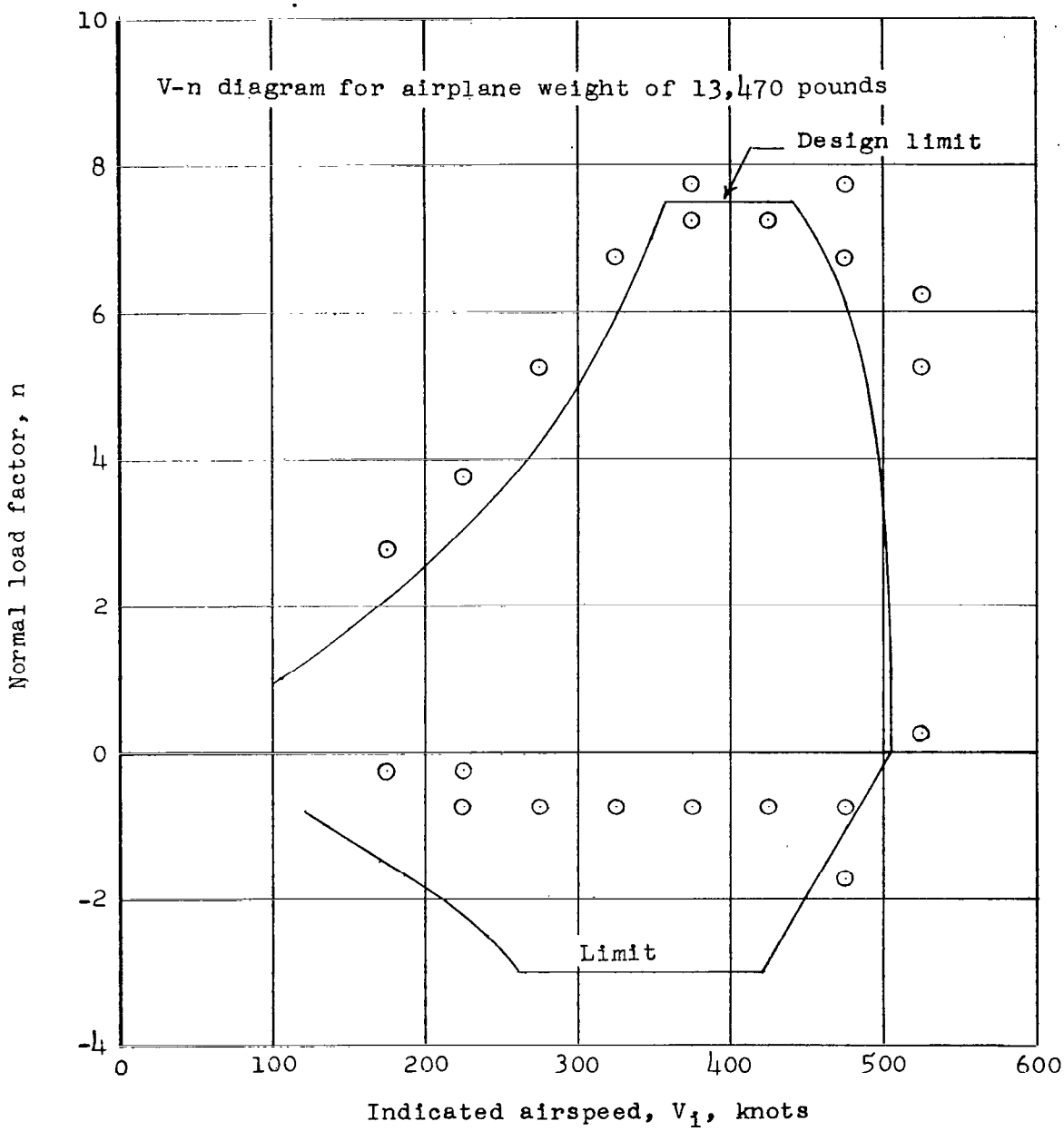

Figure 3.- Comparison of experimental load-factor peaks with operational V-n diagram. Grumman F9F-2B airplane (1370 hours).

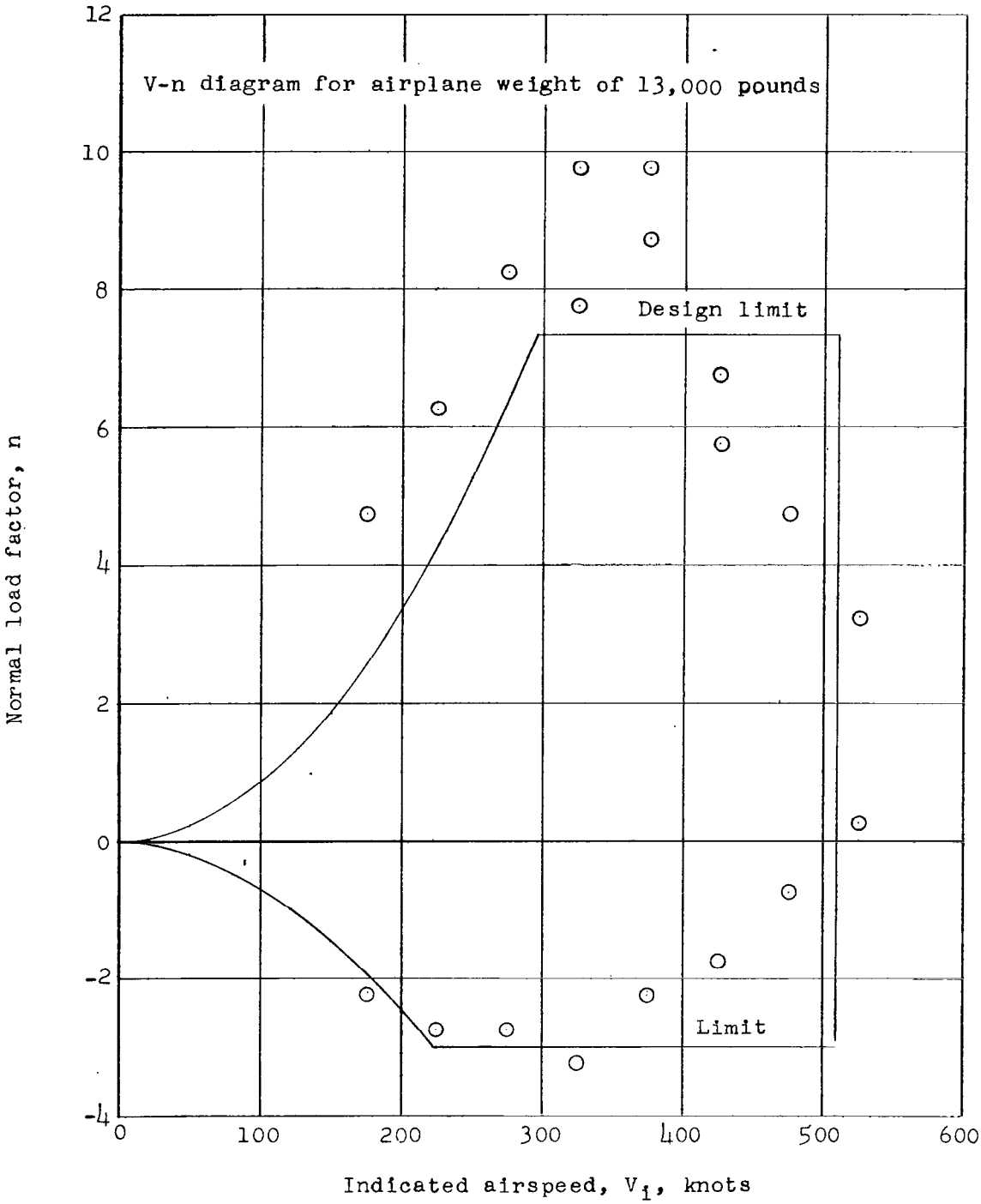

Figure 4.- Comparison of experimental load-factor peaks with operational V-n diagram. Lockheed TV-1 airplane (5659 hours).

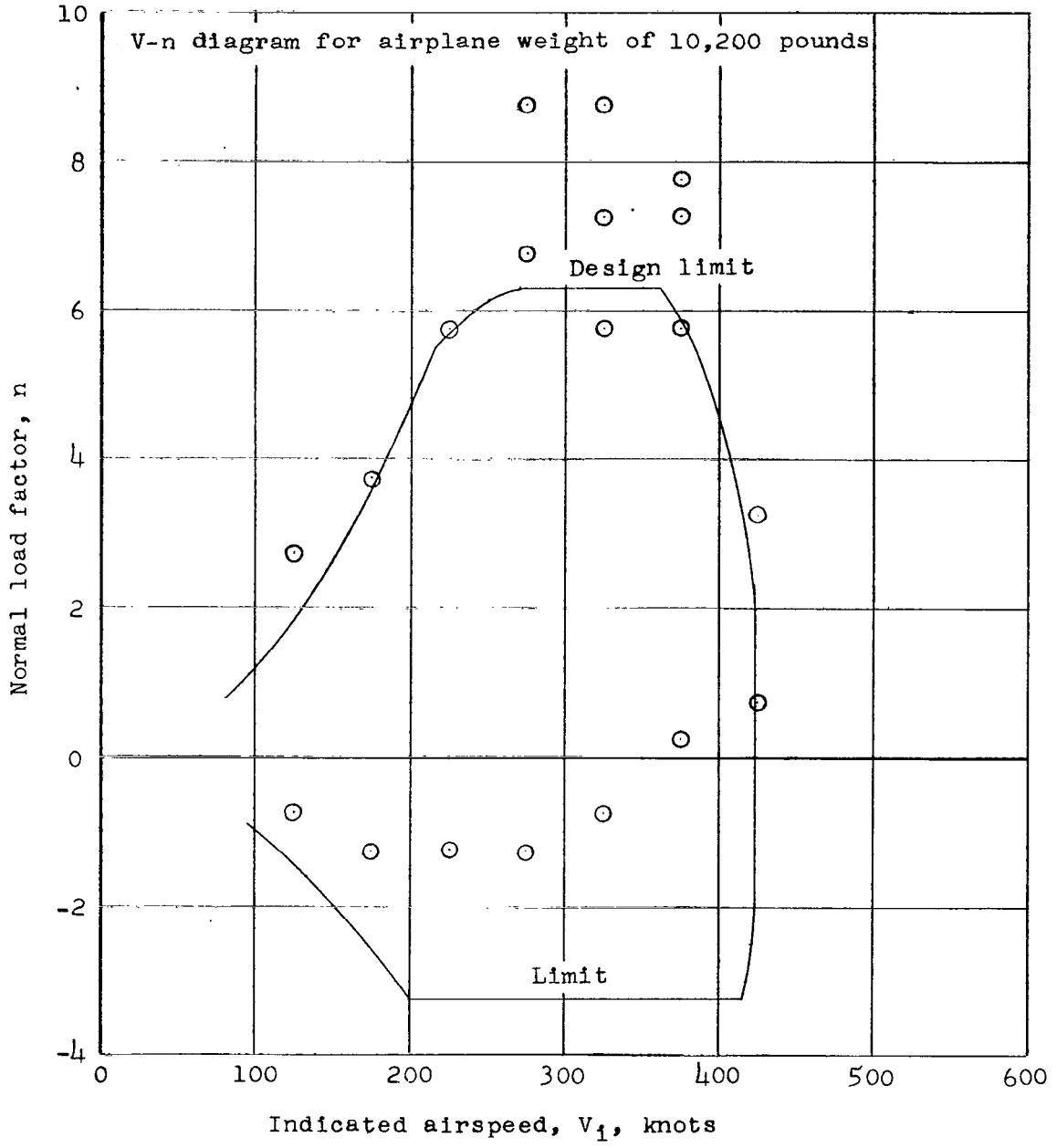

Figure 5.- Comparison of experimental load-factor peaks with operational V-n diagram. Grumman F8F-2 airplane (1092 hours).

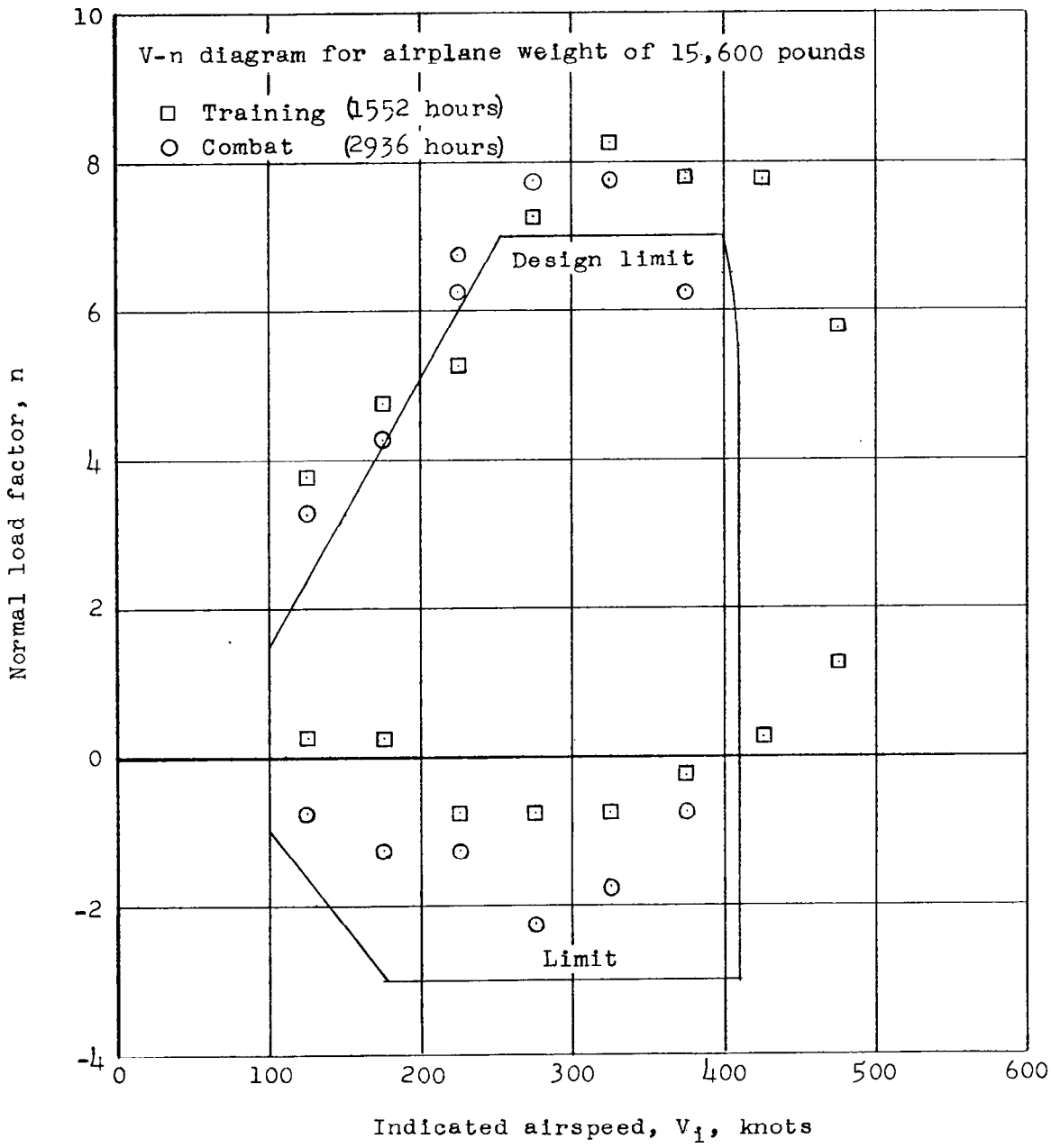

Figure 6.- Comparison of experimental load-factor peaks with operational V-n diagram. Douglas AD-4 airplane.

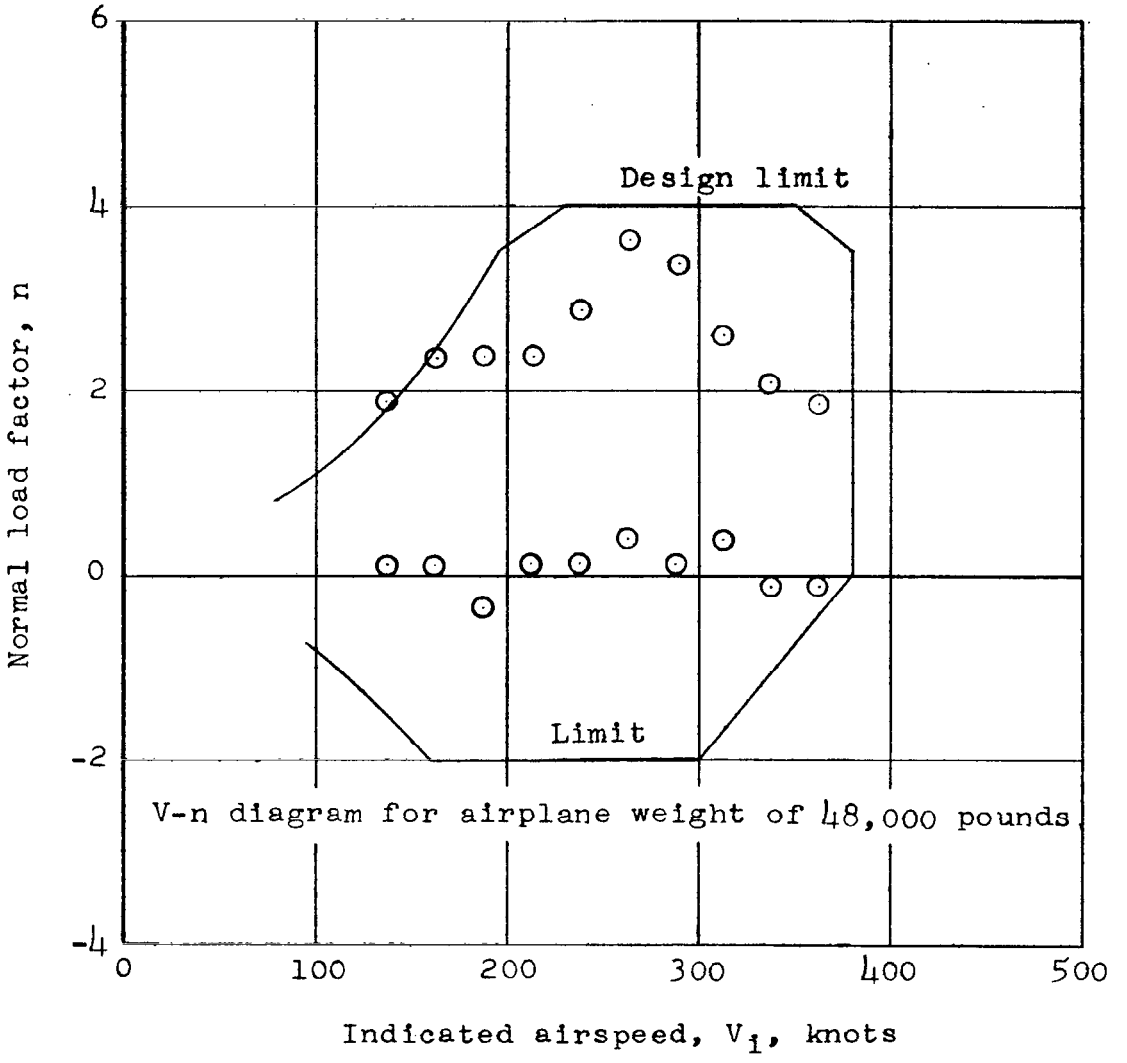

Figure 7.- Comparison of experimental load-factor peaks with operational V-n diagram. North American AJ-1 airplane (351 hours).

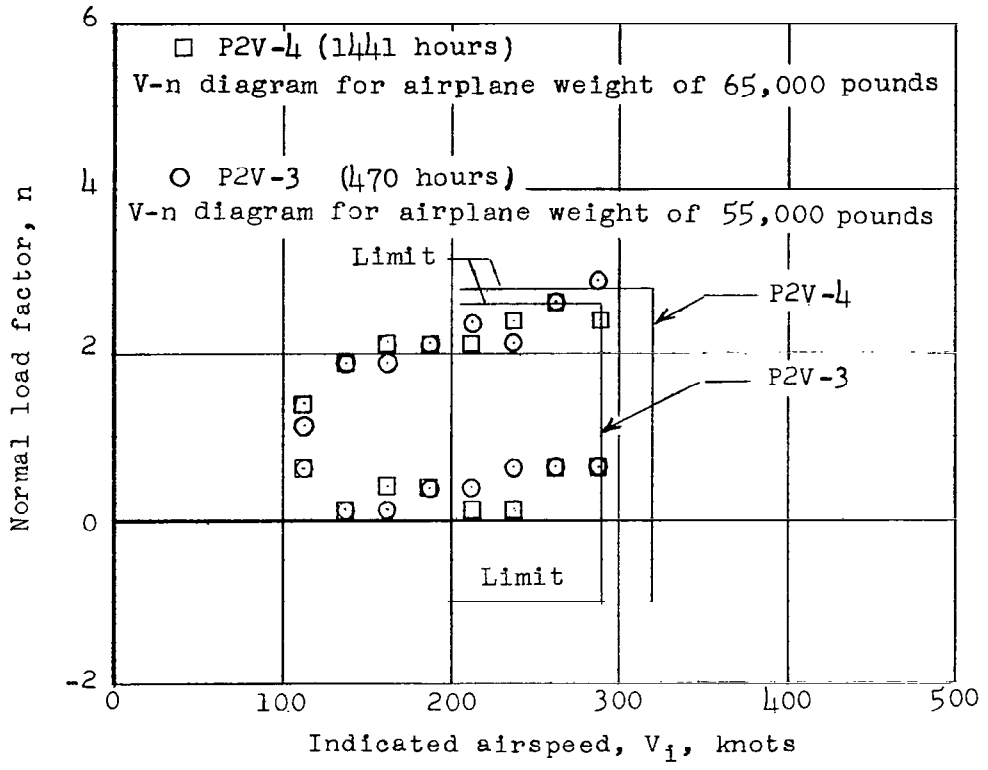

Figure 8.- Comparison of experimental load-factor peaks with operational V-n diagram. Lockheed P2V airplanes.

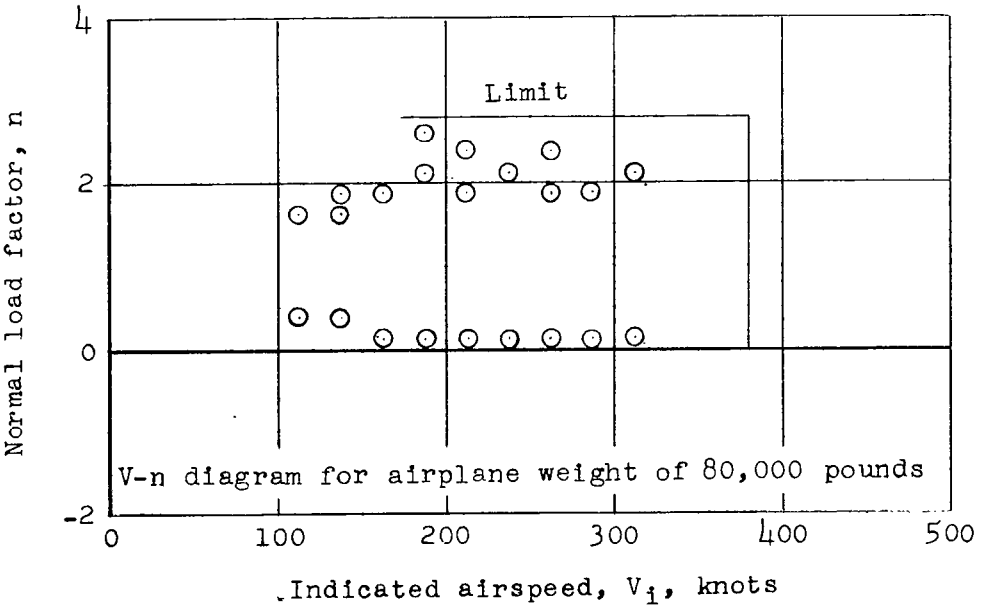

Figure 9.- Comparison of experimental load-factor peaks with operational V-n diagram. Martin P4M-1 airplane (916 hours).

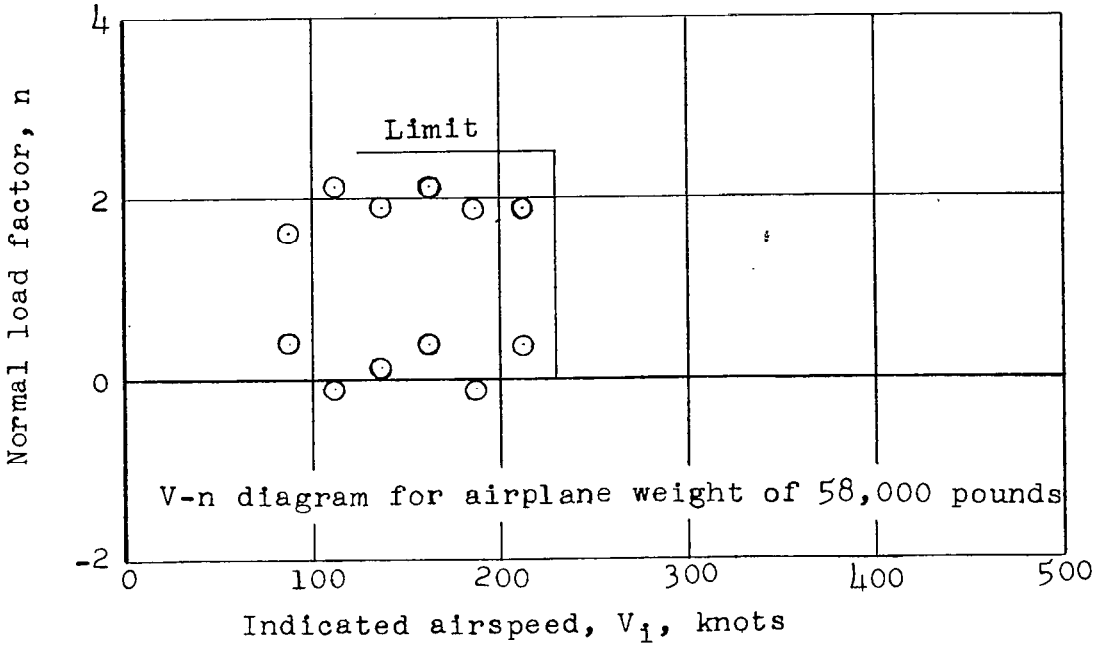

Figure 10.- Comparison of experimental load-factor peaks with operational V-n diagram. Consolidated Vultee P4Y-2S airplane (2078 hours).

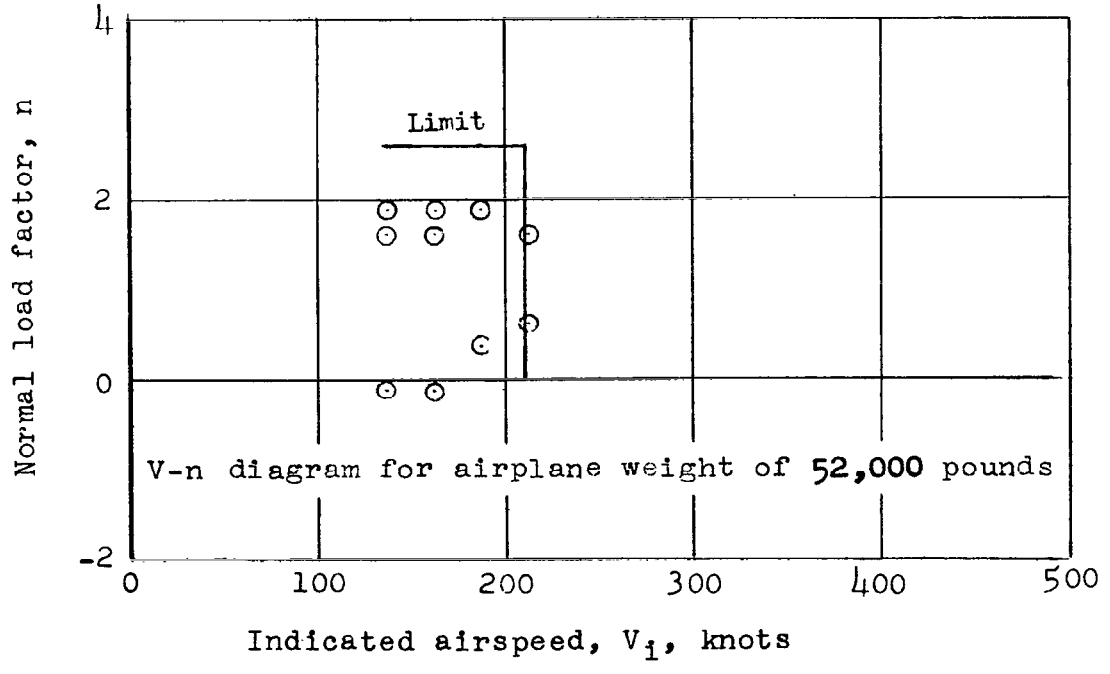

Figure 11.- Comparison of experimental load-factor peaks with operational V-n diagram. Martin PBM-5S airplane (1072 hours).

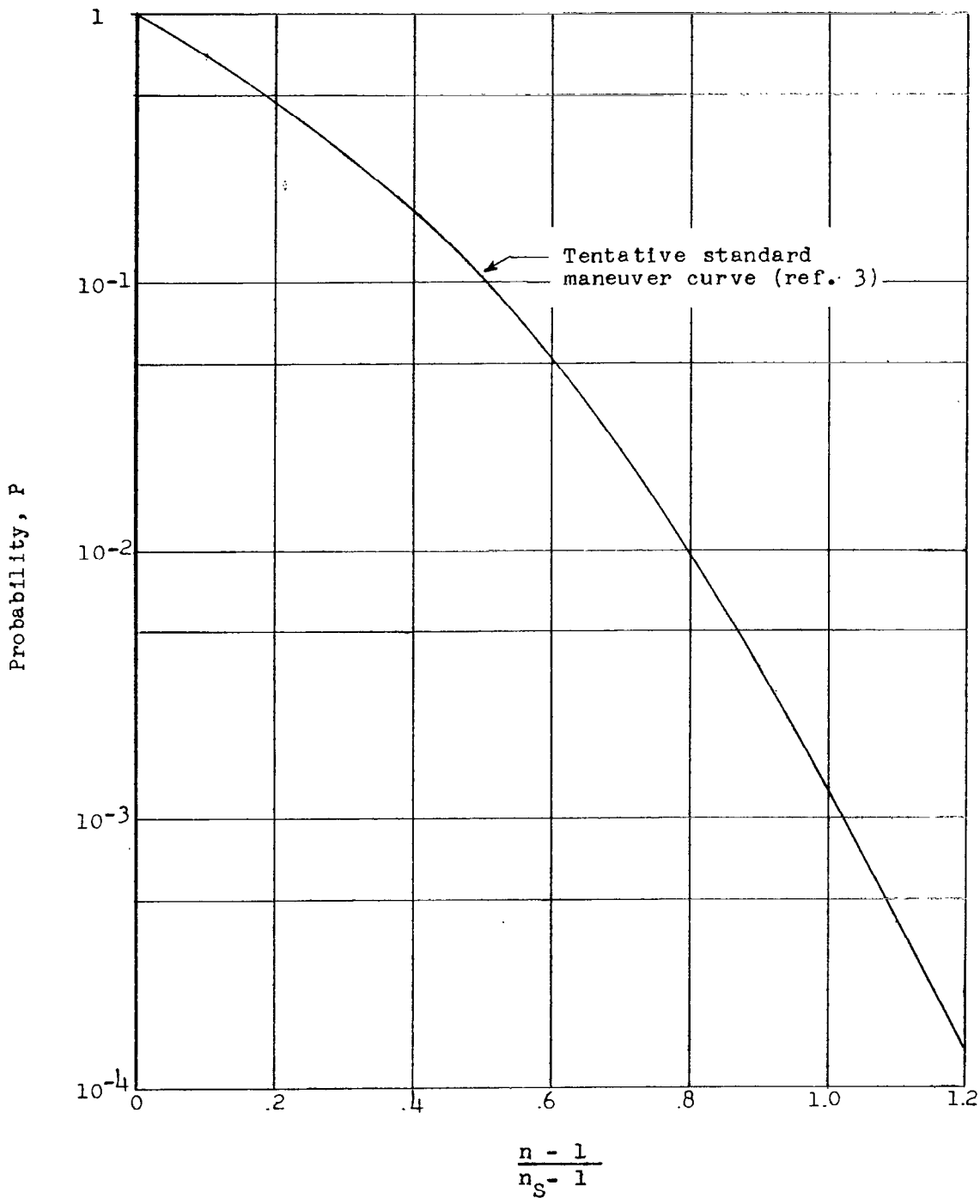

Figure 12.- Tentative standard curve of probability of exceeding a given fraction of the service limit normal load factor in maneuvers for load factors greater than 1.

[redacted]

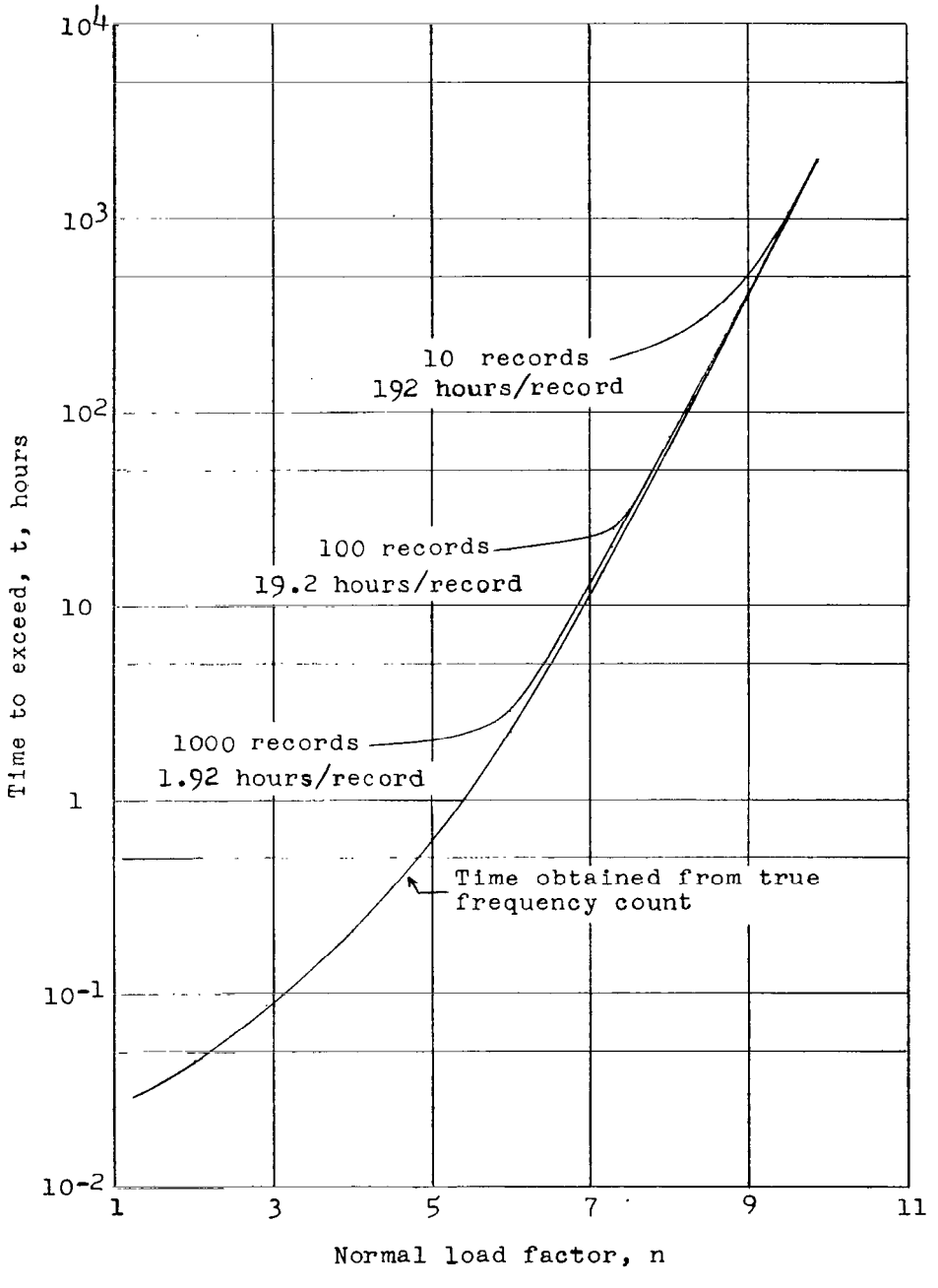

Figure 13.- Hypothetical example showing the manner in which V-G records approximate true frequency counts. (n_s, 7.33; p, 40; total flight time, 1920 hours).

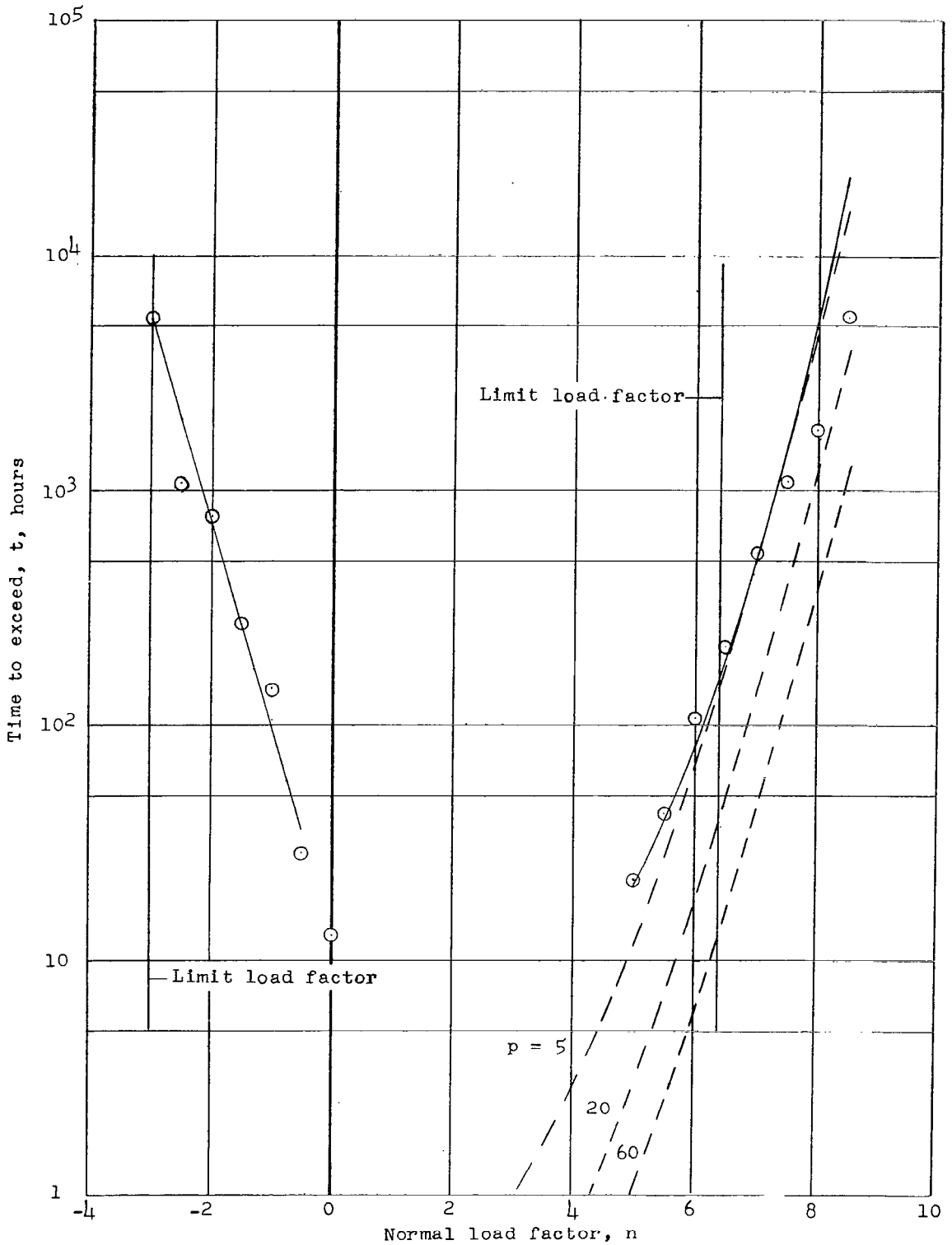

Figure 14.- Average flight time required to exceed a given positive and negative load factor. McDonnell F2H-2 airplane.

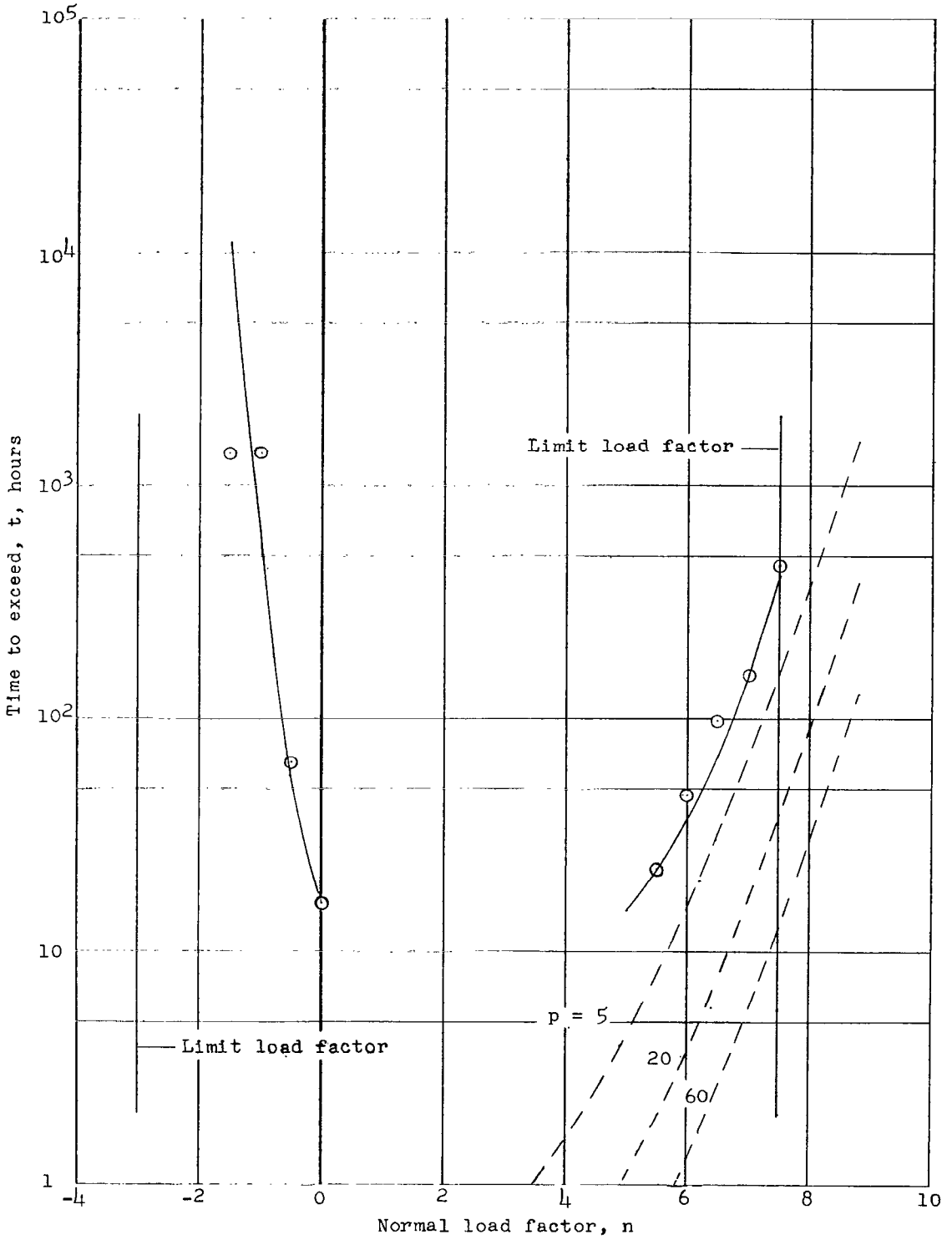

Figure 15.- Average flight time required to exceed a given positive and negative load factor. Grumman F9F-2B airplane.

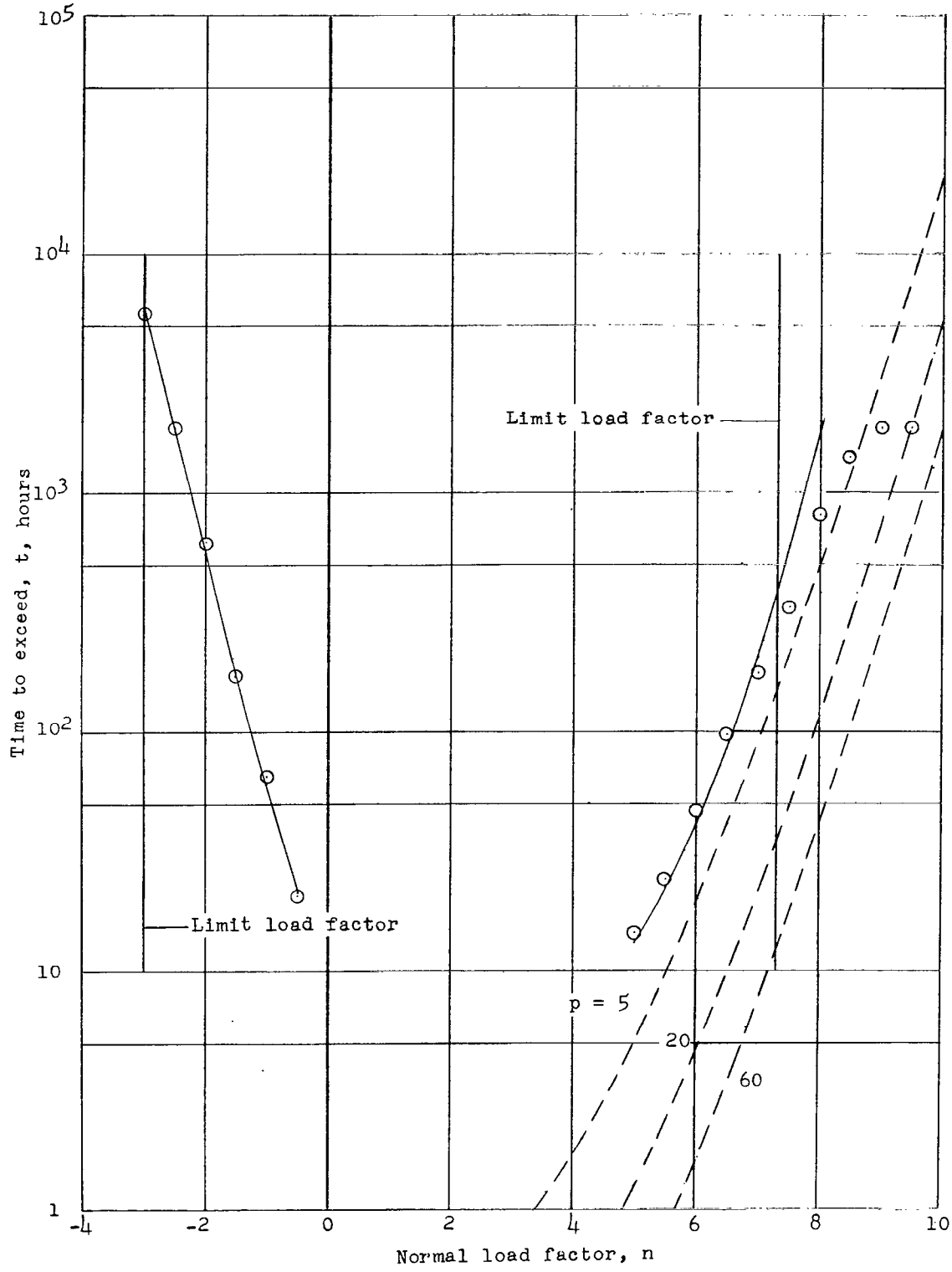

Figure 16.- Average flight time required to exceed a given positive and negative load factor. Lockheed TV-1 airplane.

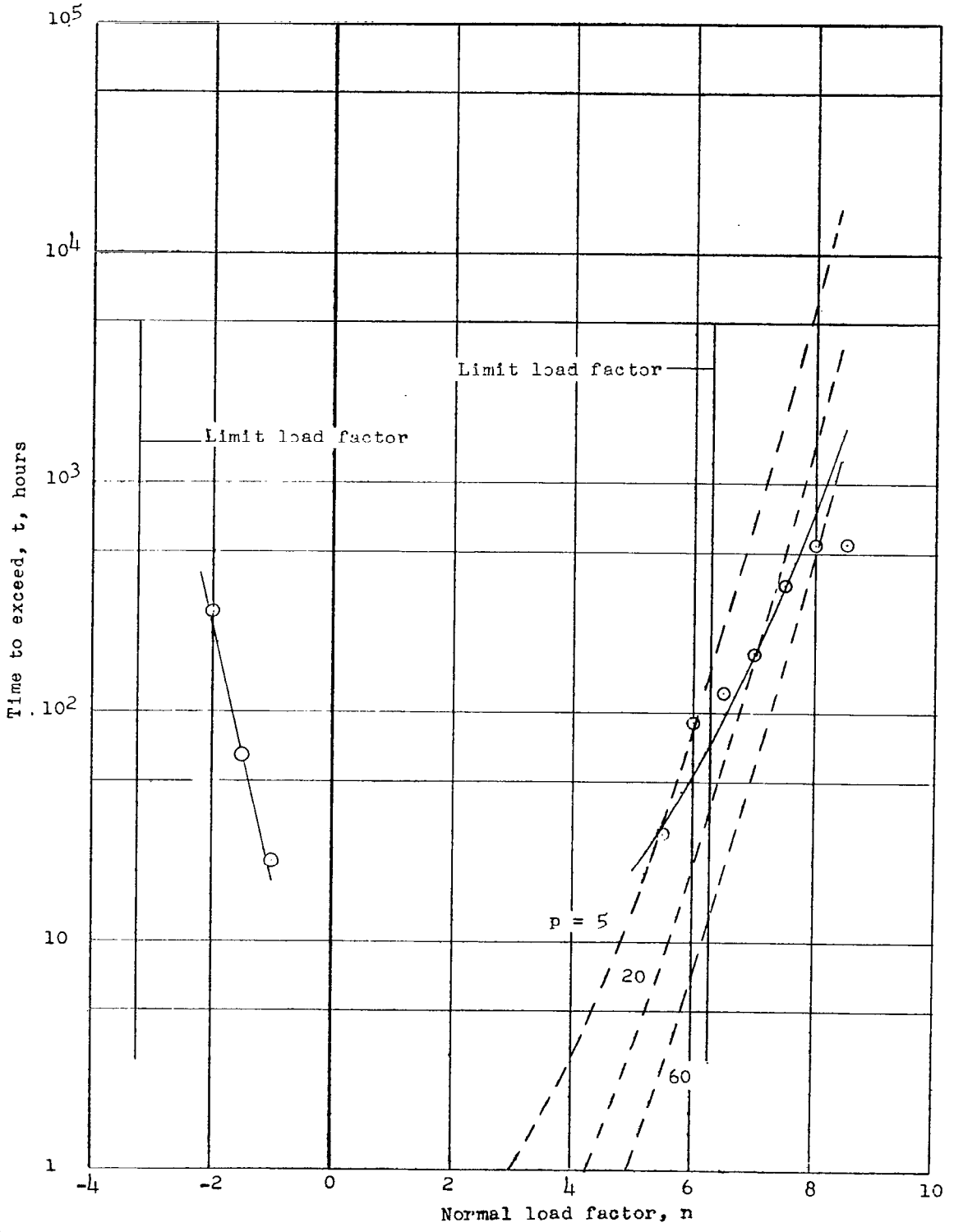

Figure 17.- Average flight time required to exceed a given positive and negative load factor. Grumman F8F-2 airplane.

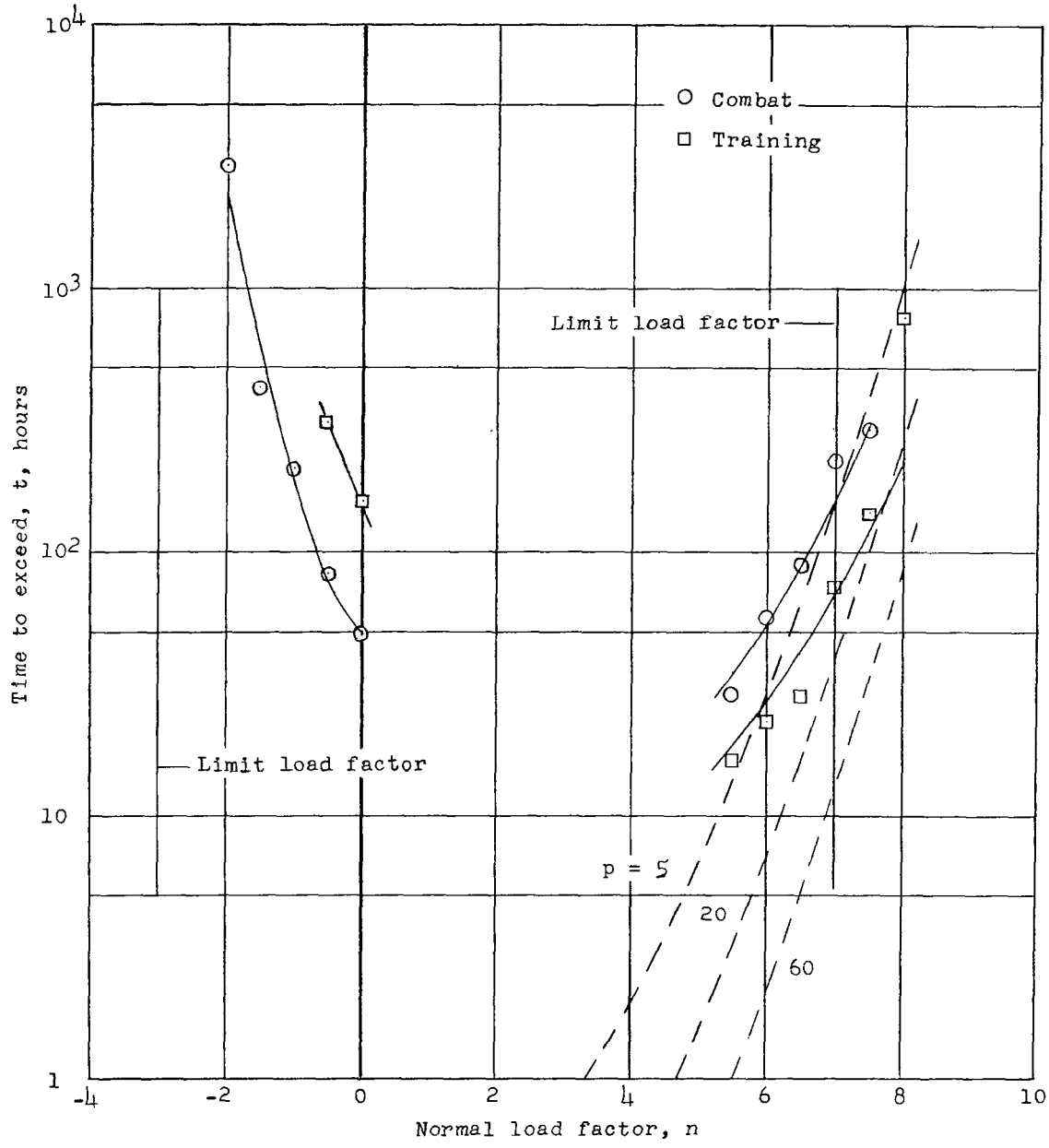

Figure 18.- Average flight time required to exceed a given positive and negative load factor. Douglas AD-4 airplane.

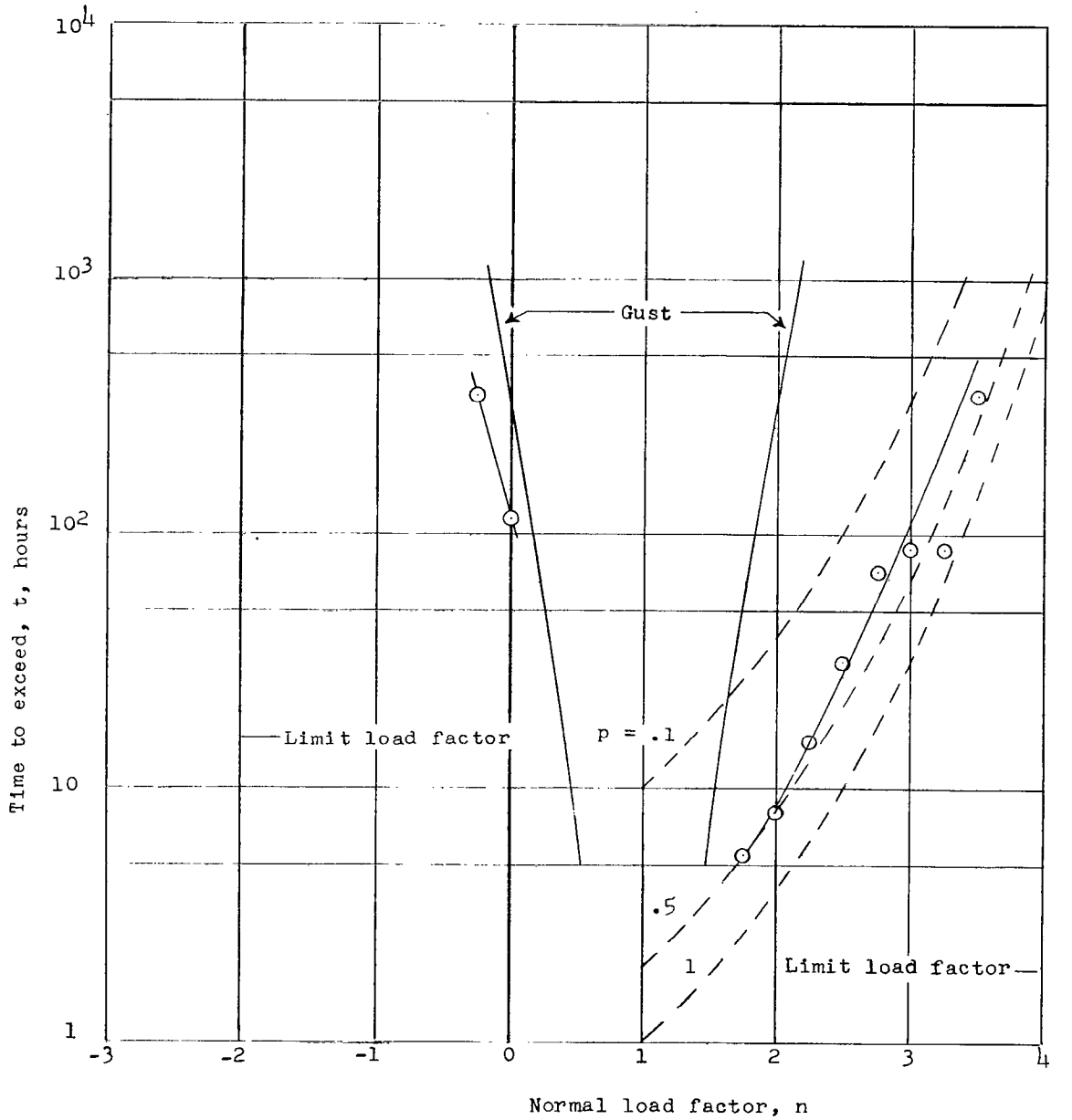

Figure 19.- Average flight time required to exceed a given positive and negative load factor. North American AJ-1 airplane.

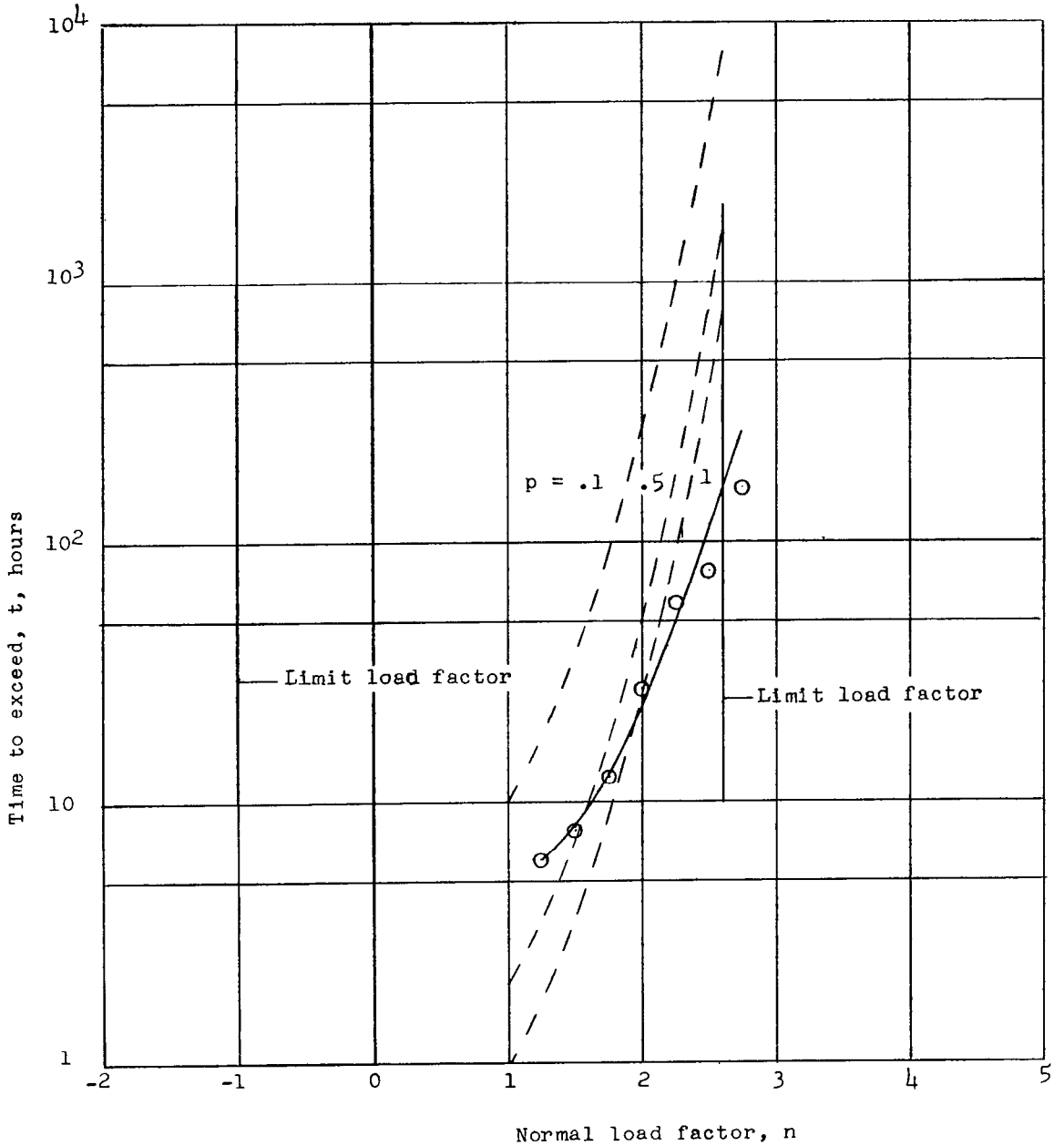

Figure 20.- Average flight time required to exceed a given positive and negative load factor. Lockheed P2V-3 airplane.

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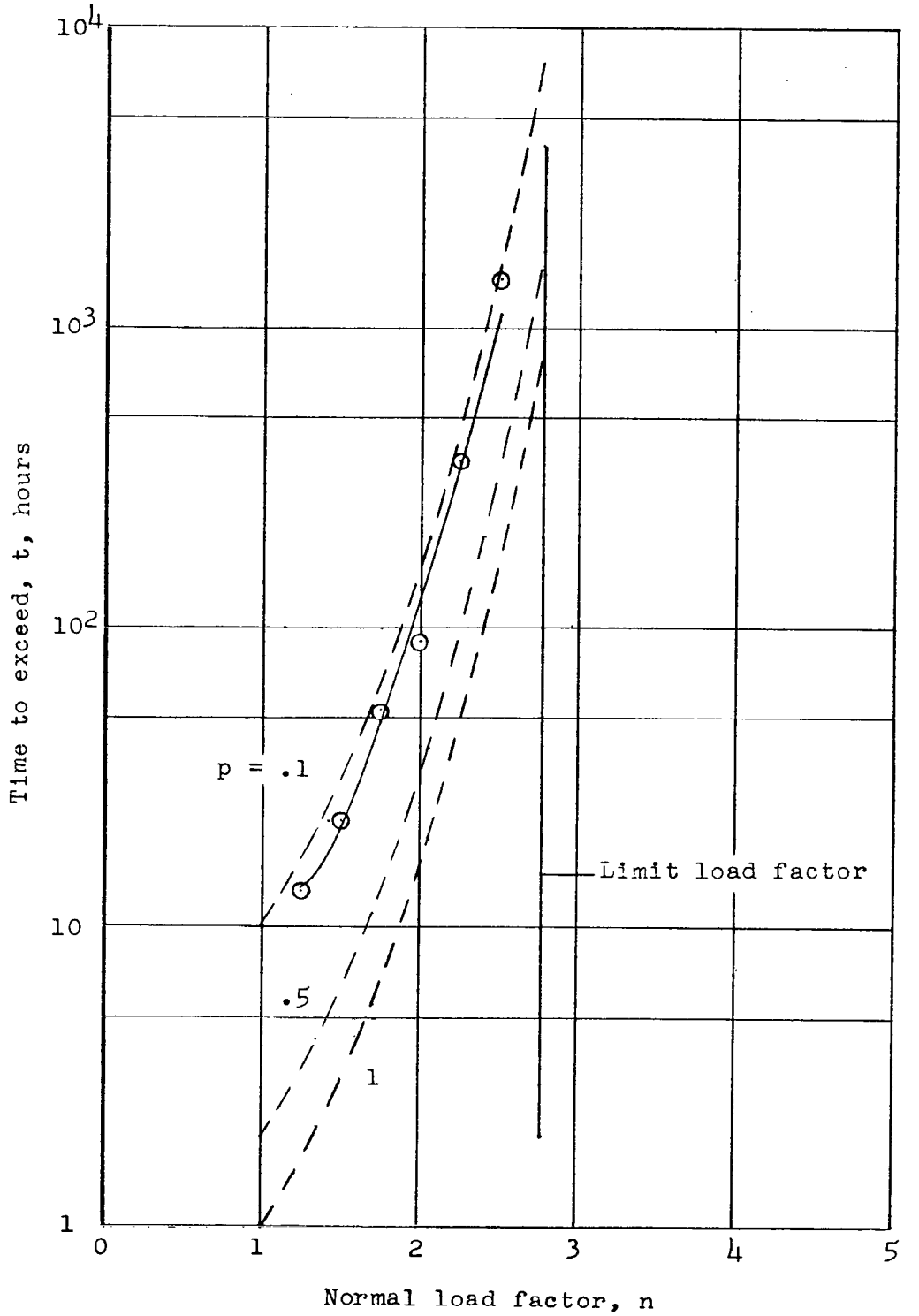

Figure 21.- Average flight time required to exceed a given positive and negative load factor. Lockheed P2V-4 airplane.

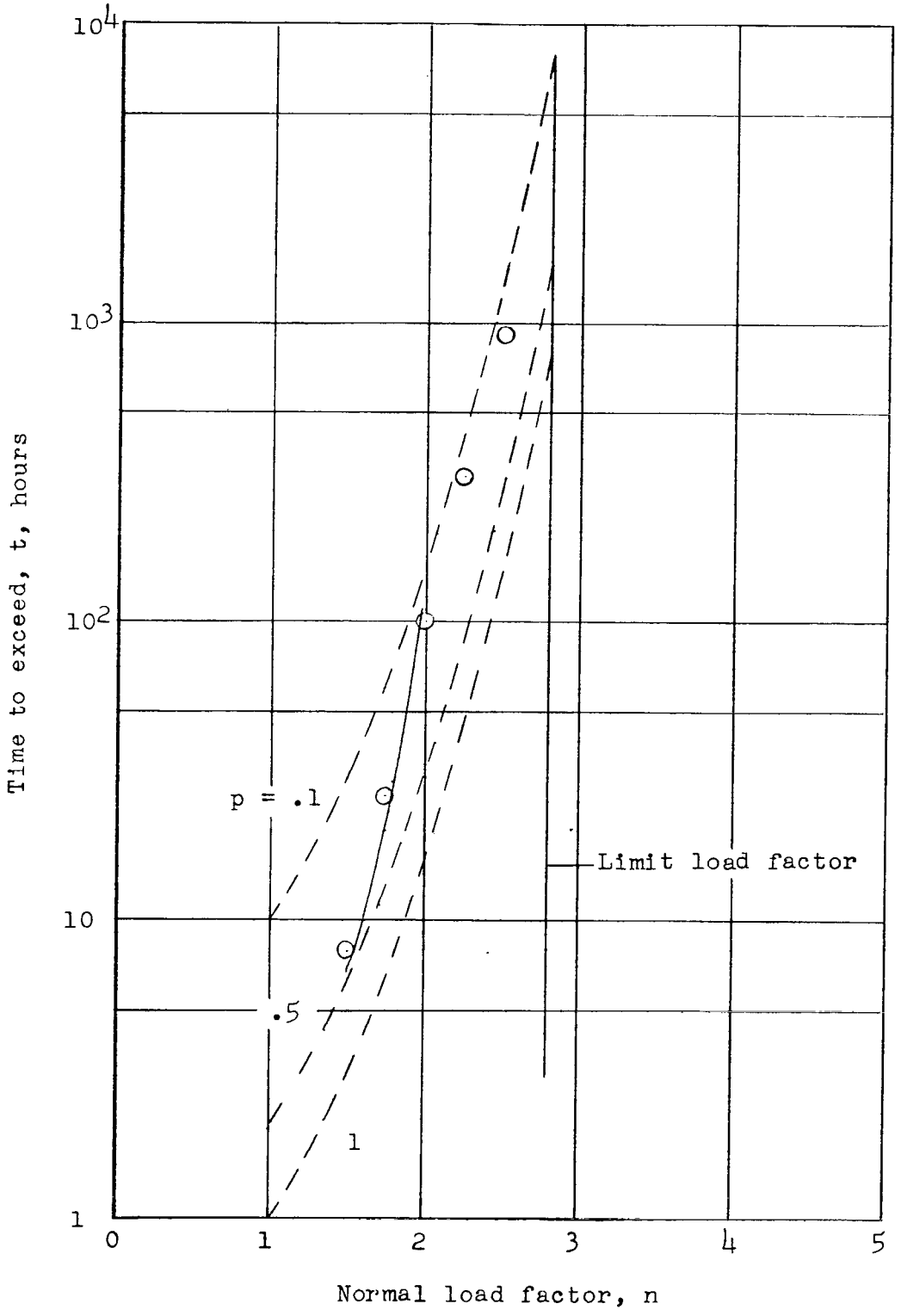

Figure 22.- Average flight time required to exceed a given positive and negative load factor. Martin P4M-1 airplane.

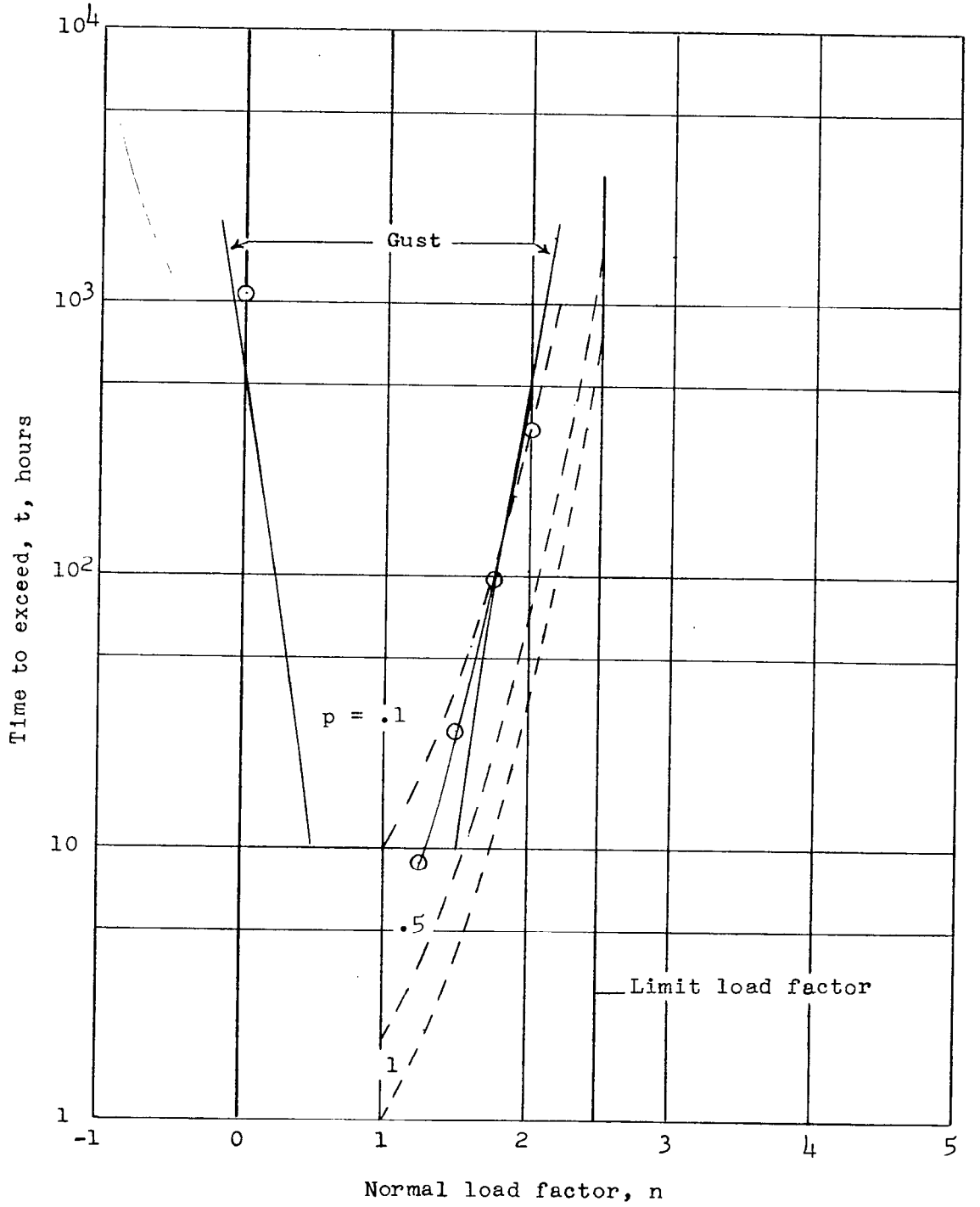

Figure 23.- Average flight time required to exceed a given positive and negative load factor. Consolidated Vultee P4Y-2S airplane.

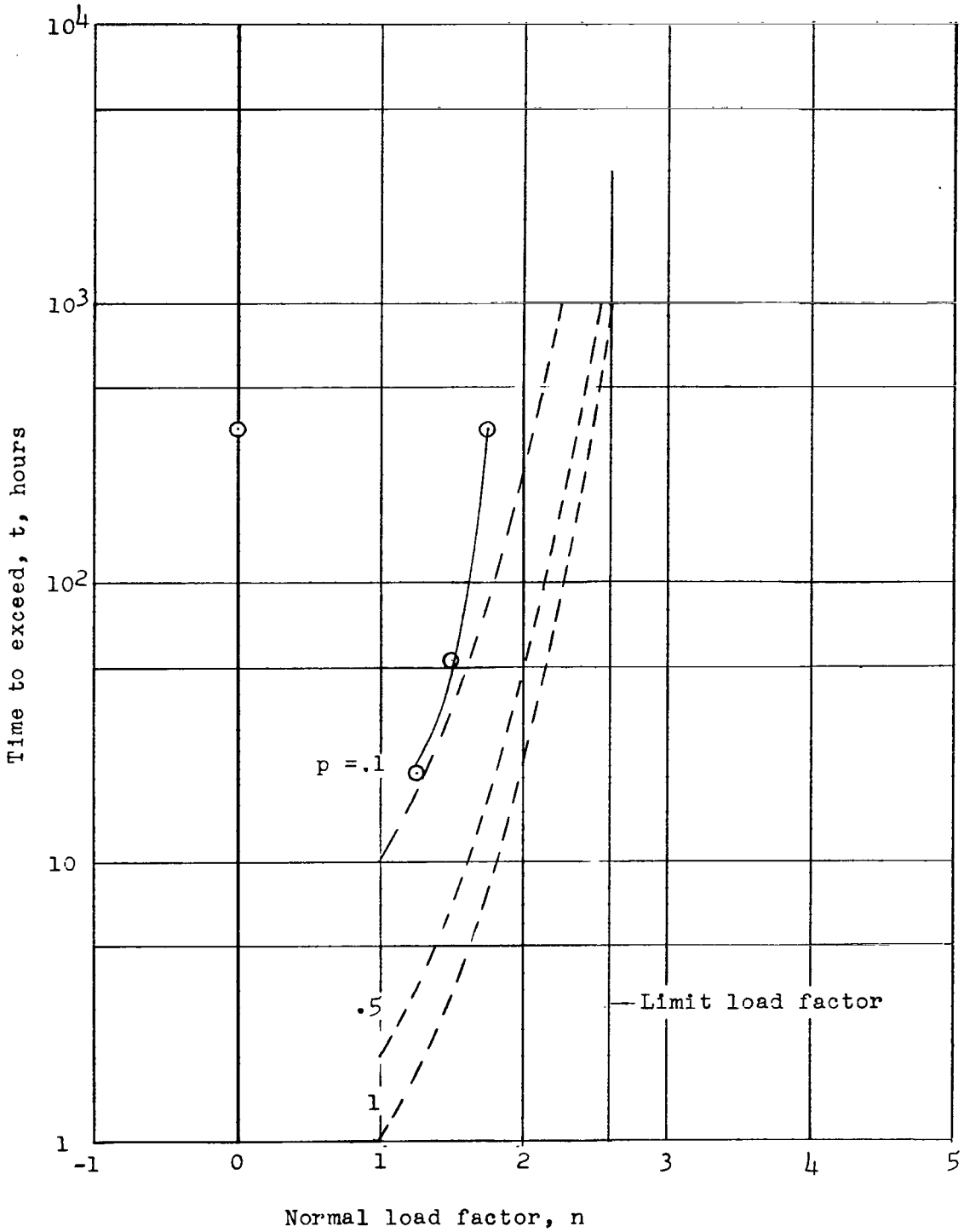

Figure 24.- Average flight time required to exceed a given positive and negative load factor. Martin PBM-5S airplane.

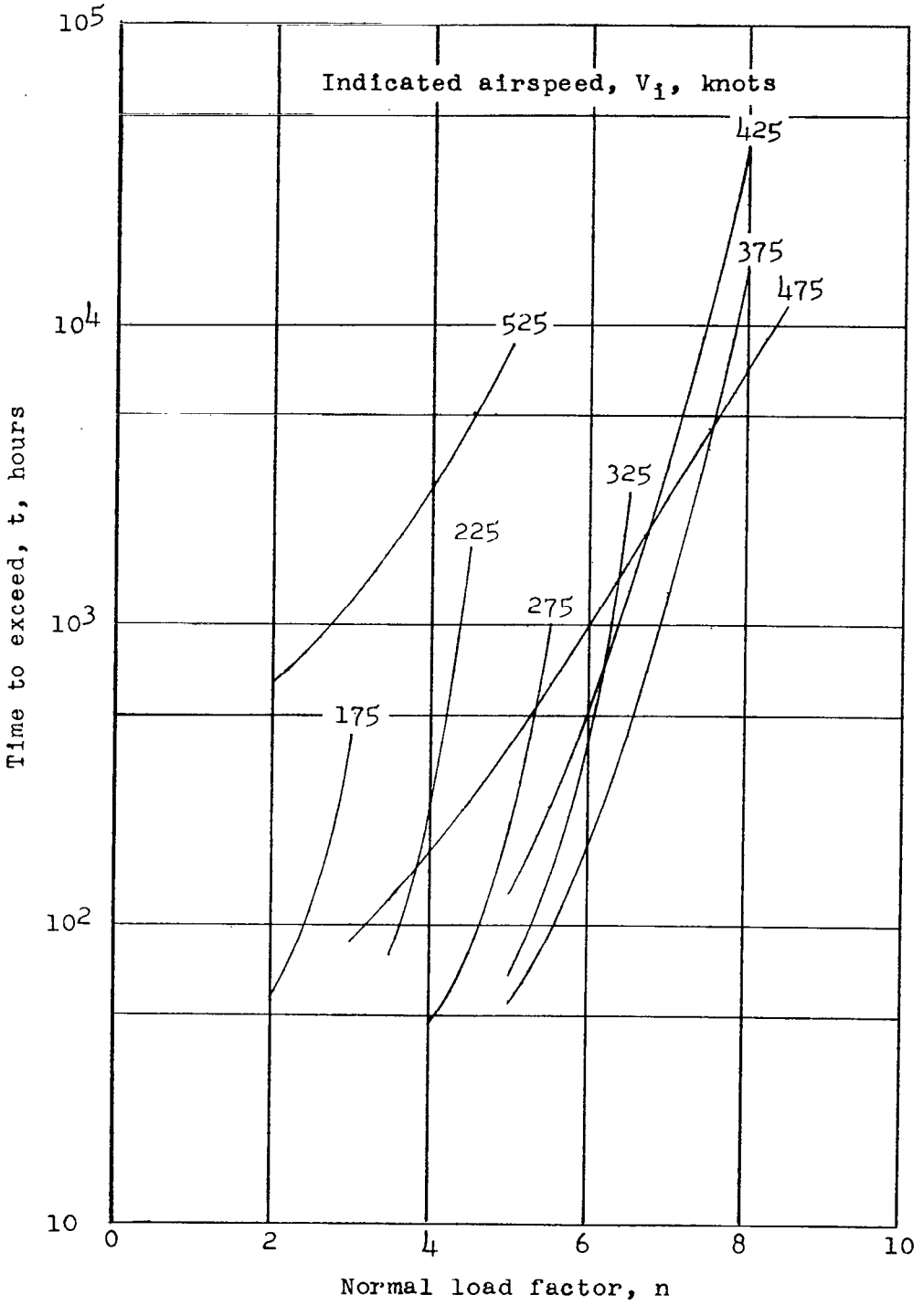

Figure 25.- Average flight time required to exceed a given load factor in a given airspeed range (based on total flight time at all speeds). McDonnell F2H-2 airplane.

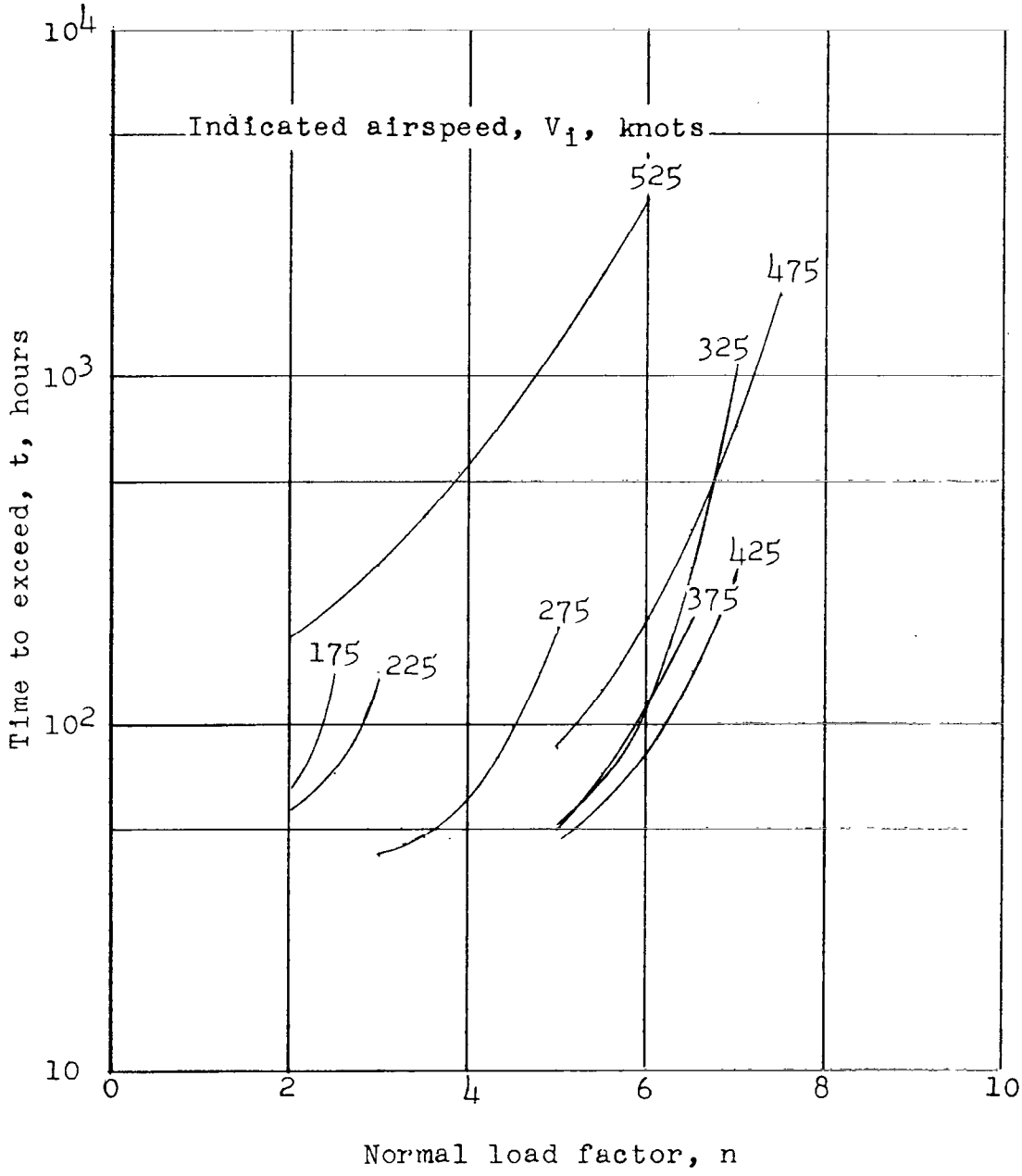

Figure 26.- Average flight time required to exceed a given load factor in a given airspeed range (based on total flight time at all speeds). Grumman F9F-2B airplane.

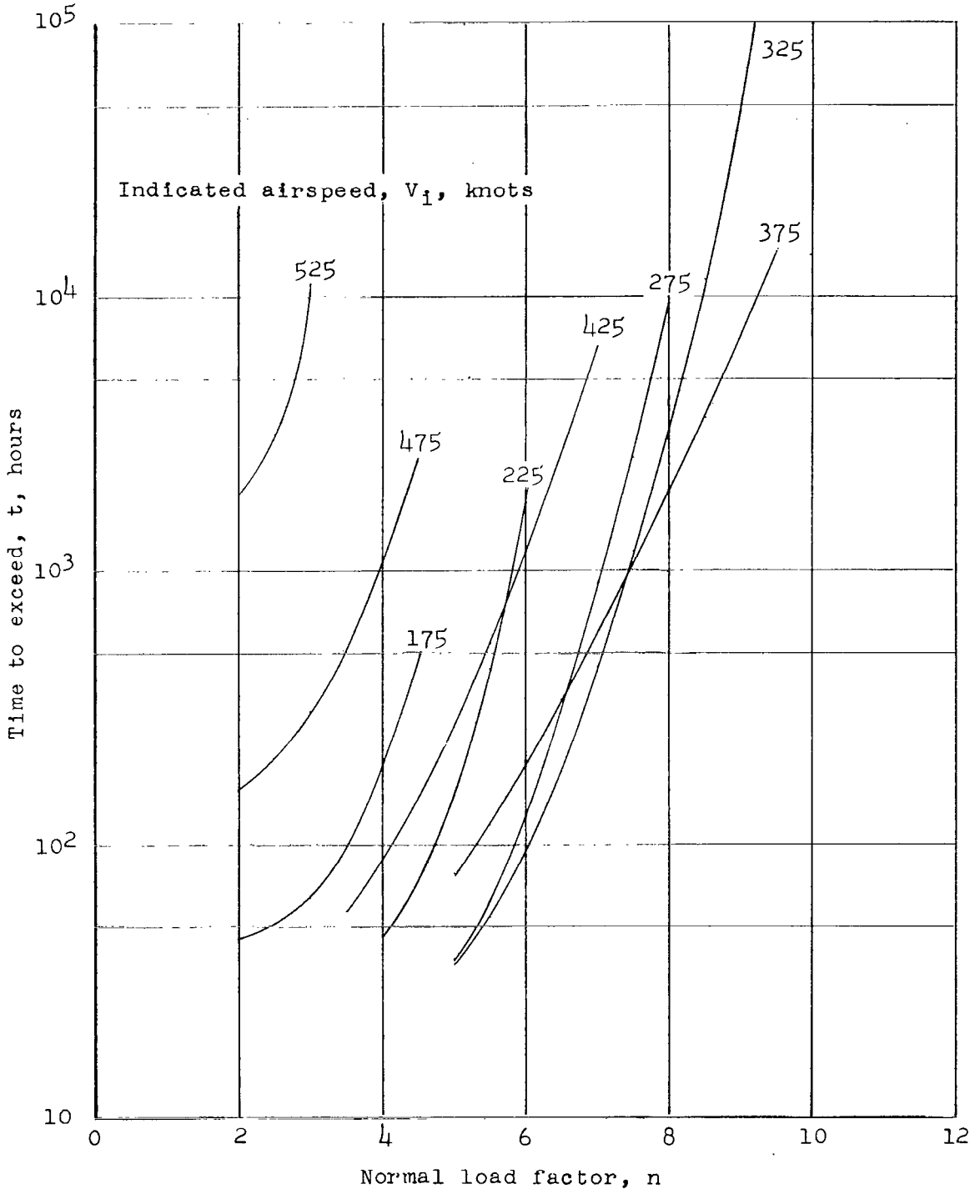

Figure 27.- Average flight time required to exceed a given load factor in a given airspeed range (based on total flight time at all speeds). Lockheed TV-1 airplane.

[redacted]

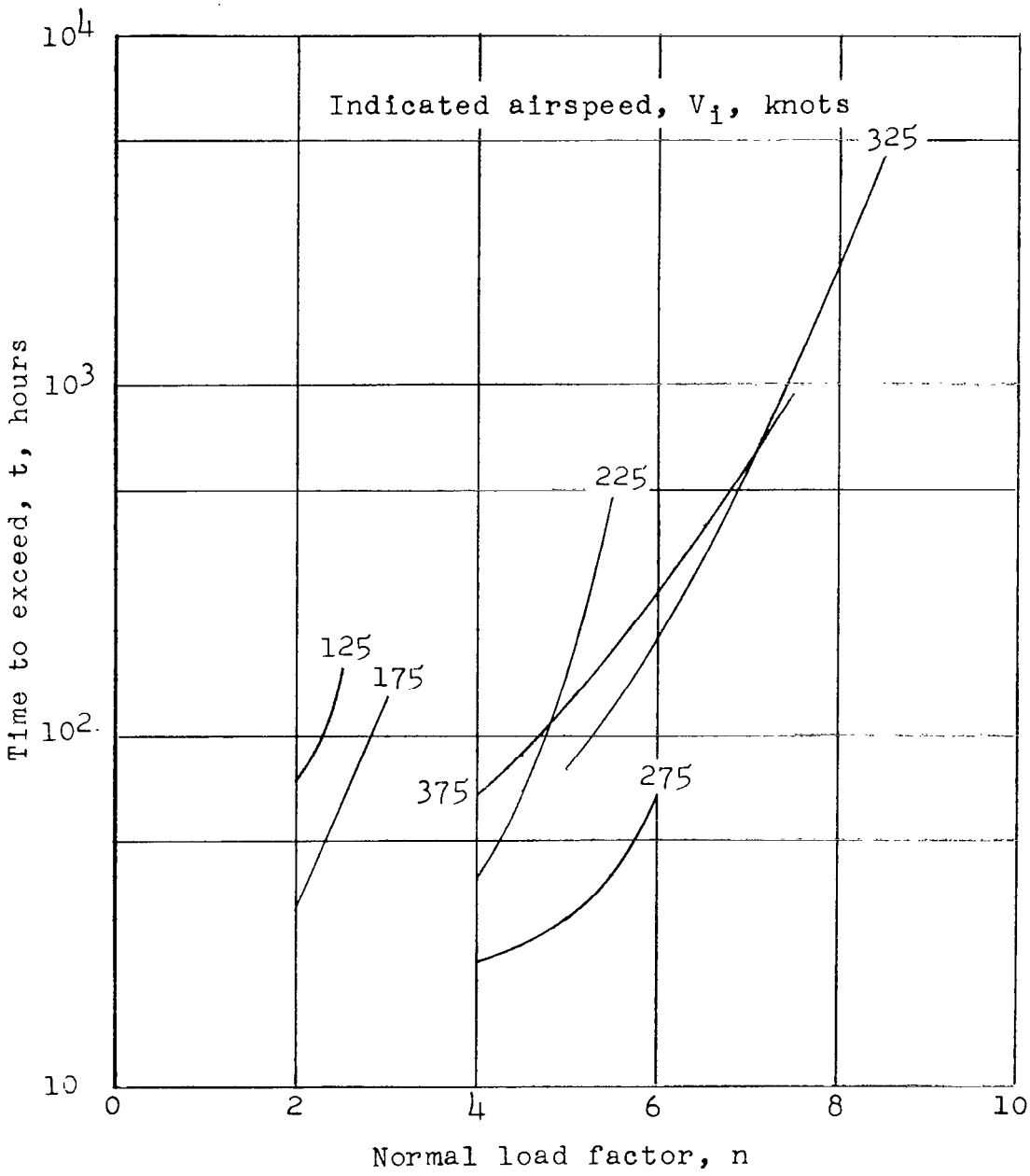

Figure 28.- Average flight time required to exceed a given load factor in a given airspeed range (based on total flight time at all speeds). Grumman F8F-2 airplane.

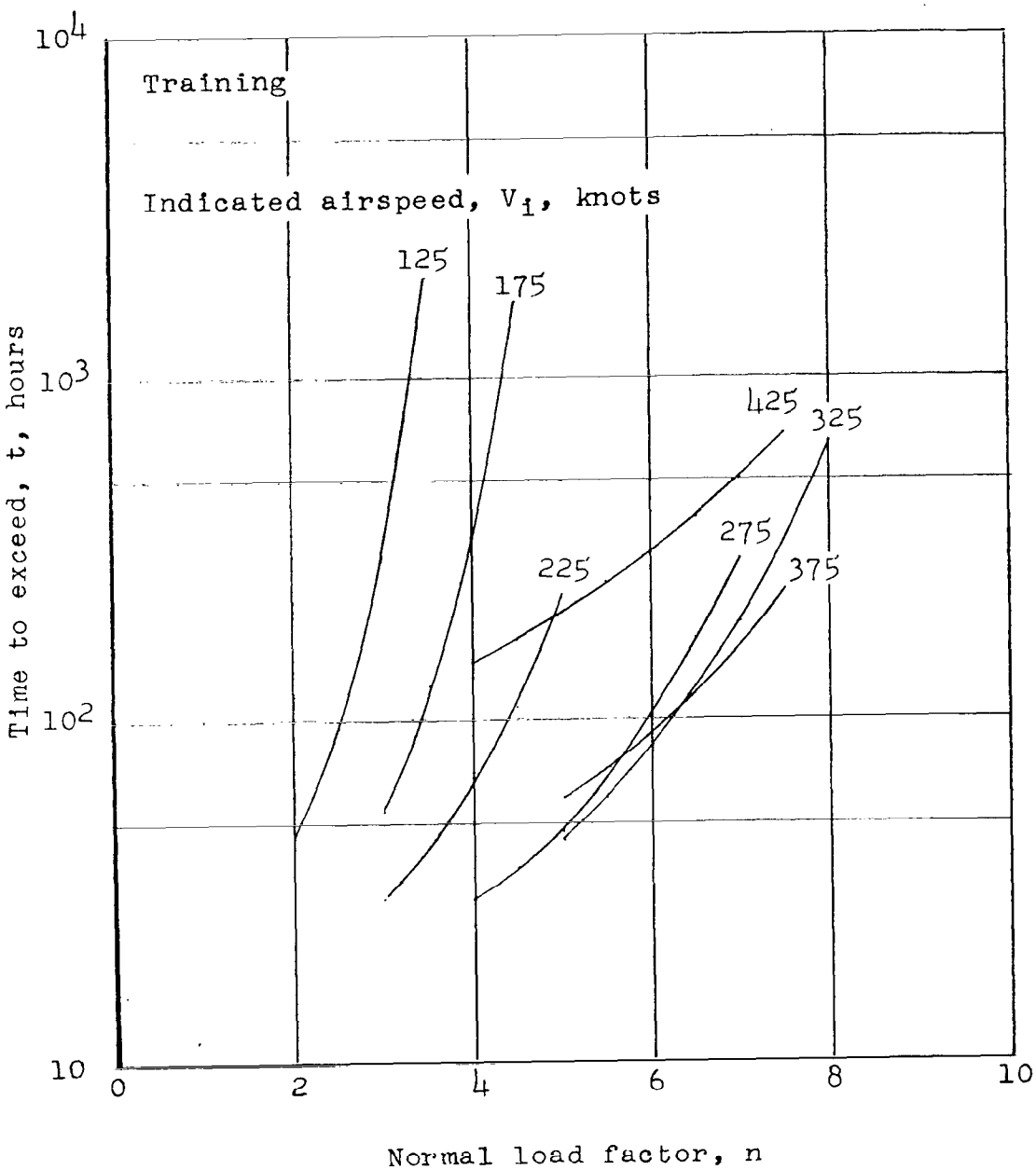

Figure 29.- Average flight time required to exceed a given load factor in a given airspeed range (based on total flight time at all speeds). Douglas AD-4 airplane.

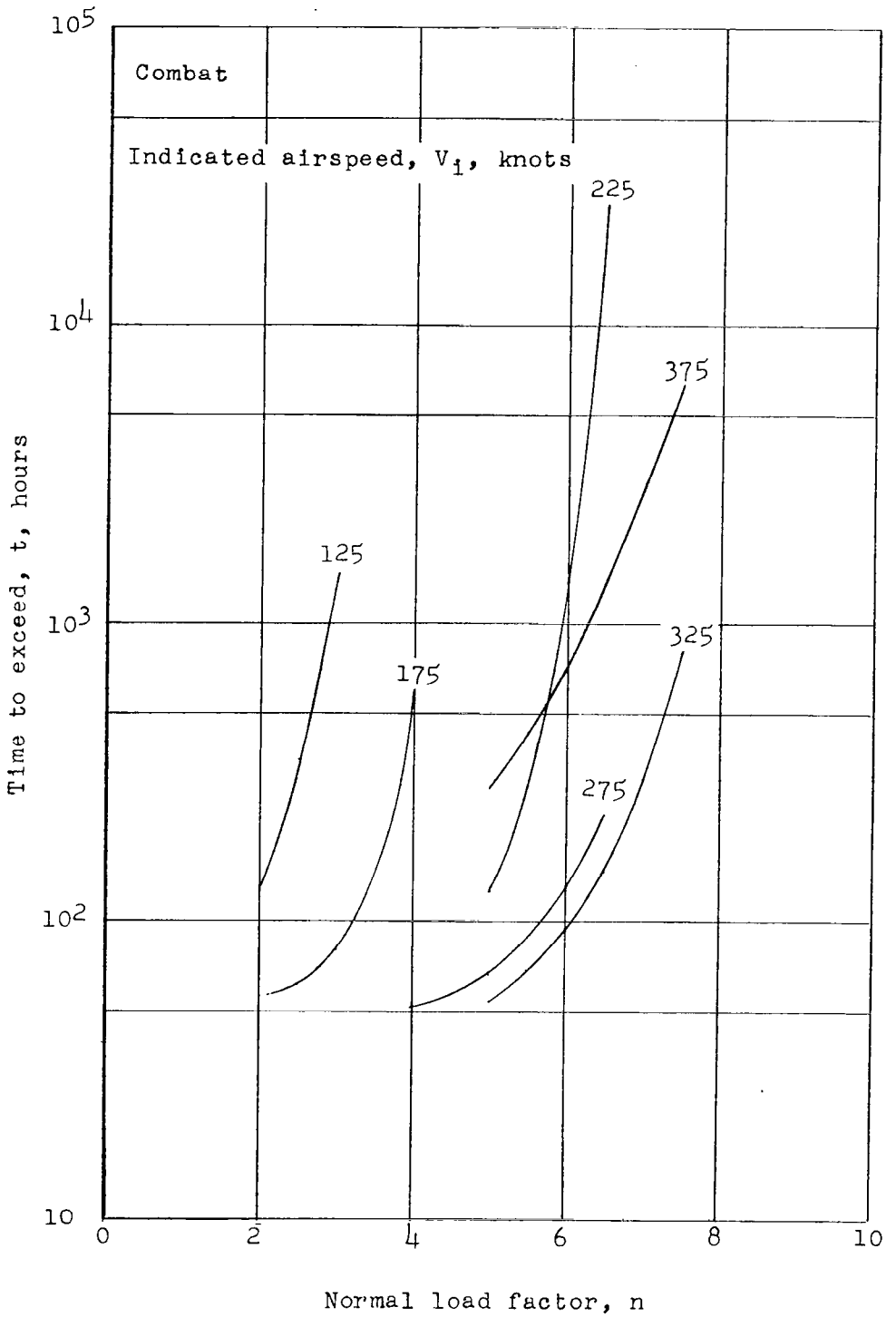

Figure 30.- Average flight time required to exceed a given load factor in a given airspeed range (based on total flight time at all speeds). Douglas AD-4 airplane.

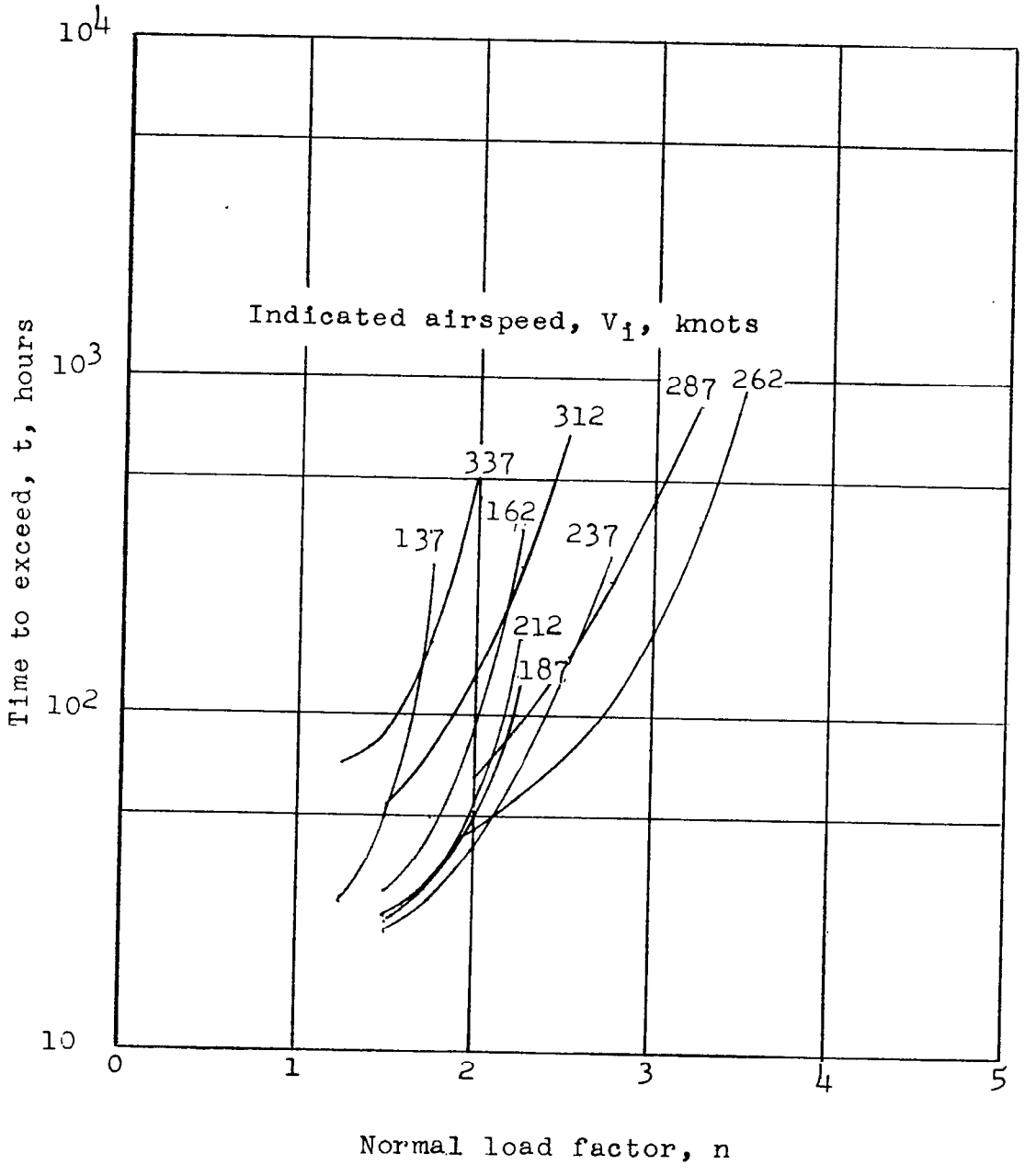

Figure 31.- Average flight time required to exceed a given load factor in a given airspeed range (based on total flight time at all speeds). North American AJ-1 airplane.

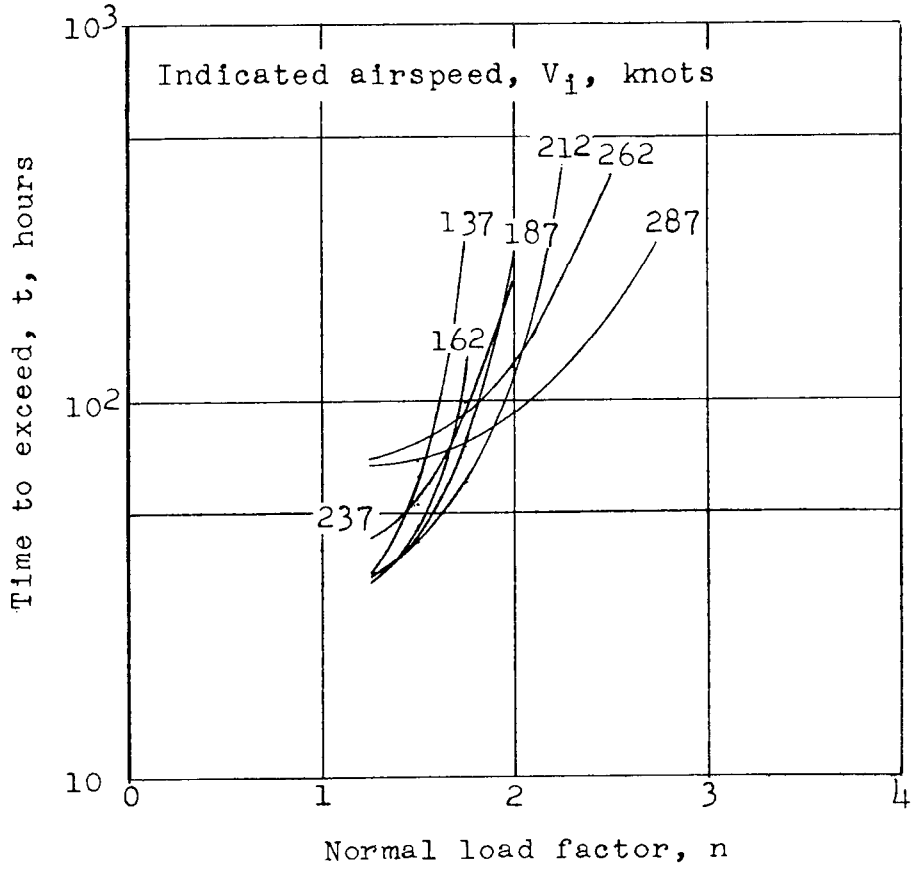

Figure 32.- Average flight time required to exceed a given load factor at a given airspeed range (based on total flight time at all speeds). Lockheed P2V-3 airplane.

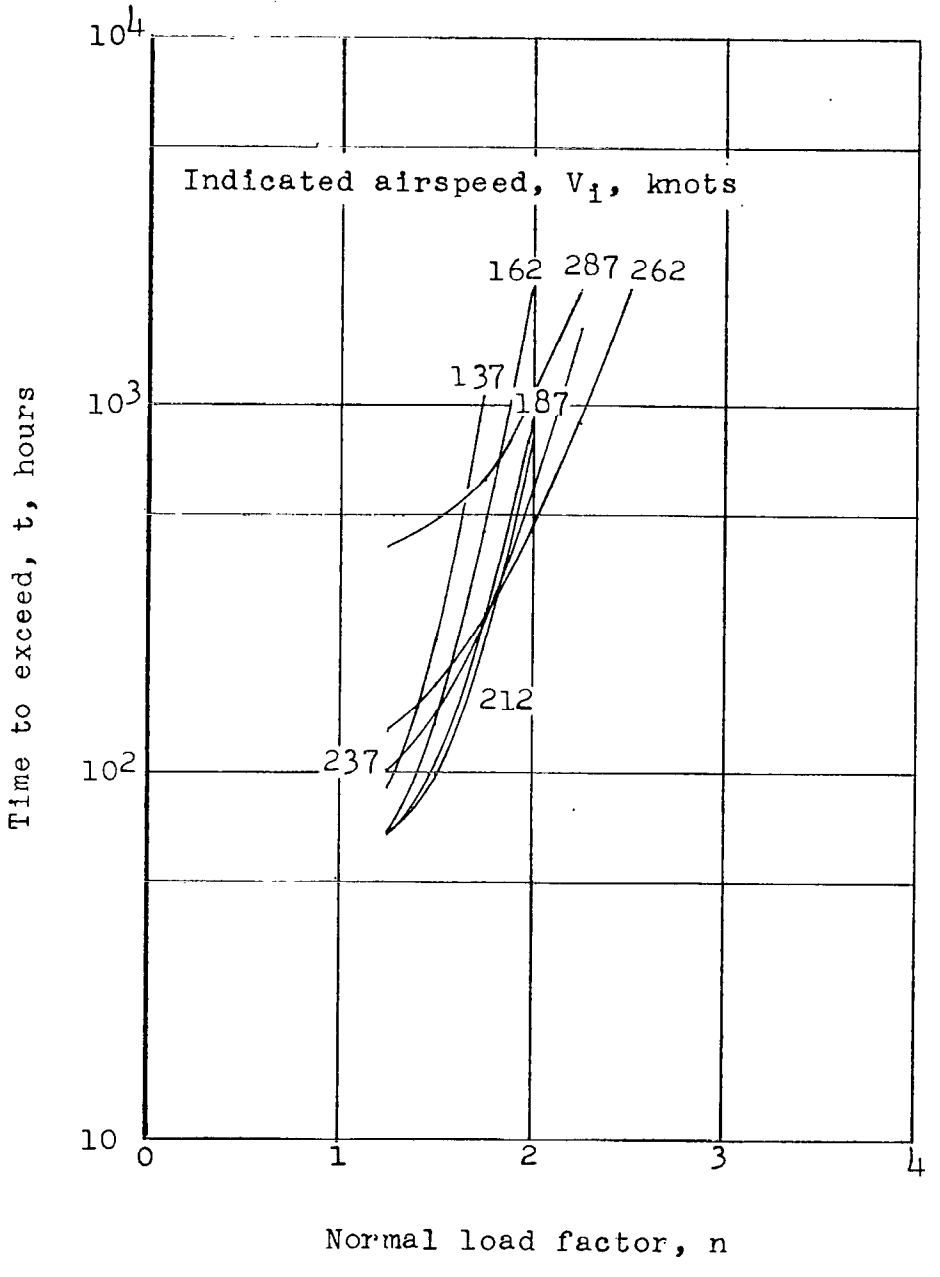

Figure 33.- Average flight time required to exceed a given load factor in a given airspeed range (based on total flight time at all speeds). Lockheed P2V-4 airplane.

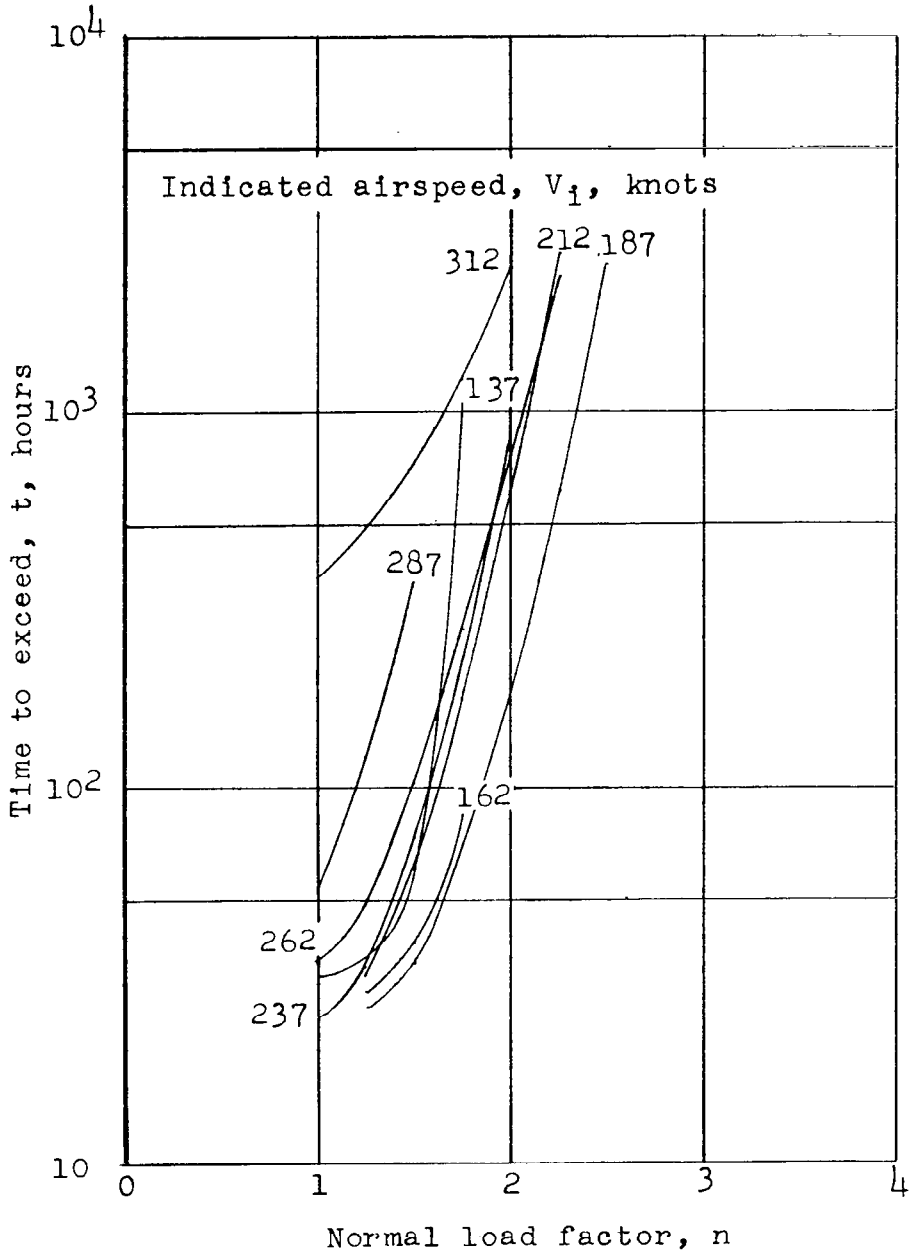

Figure 34.- Average flight time required to exceed a given load factor in a given airspeed range (based on total flight time at all speeds). Martin P4M-1 airplane.

[redacted]

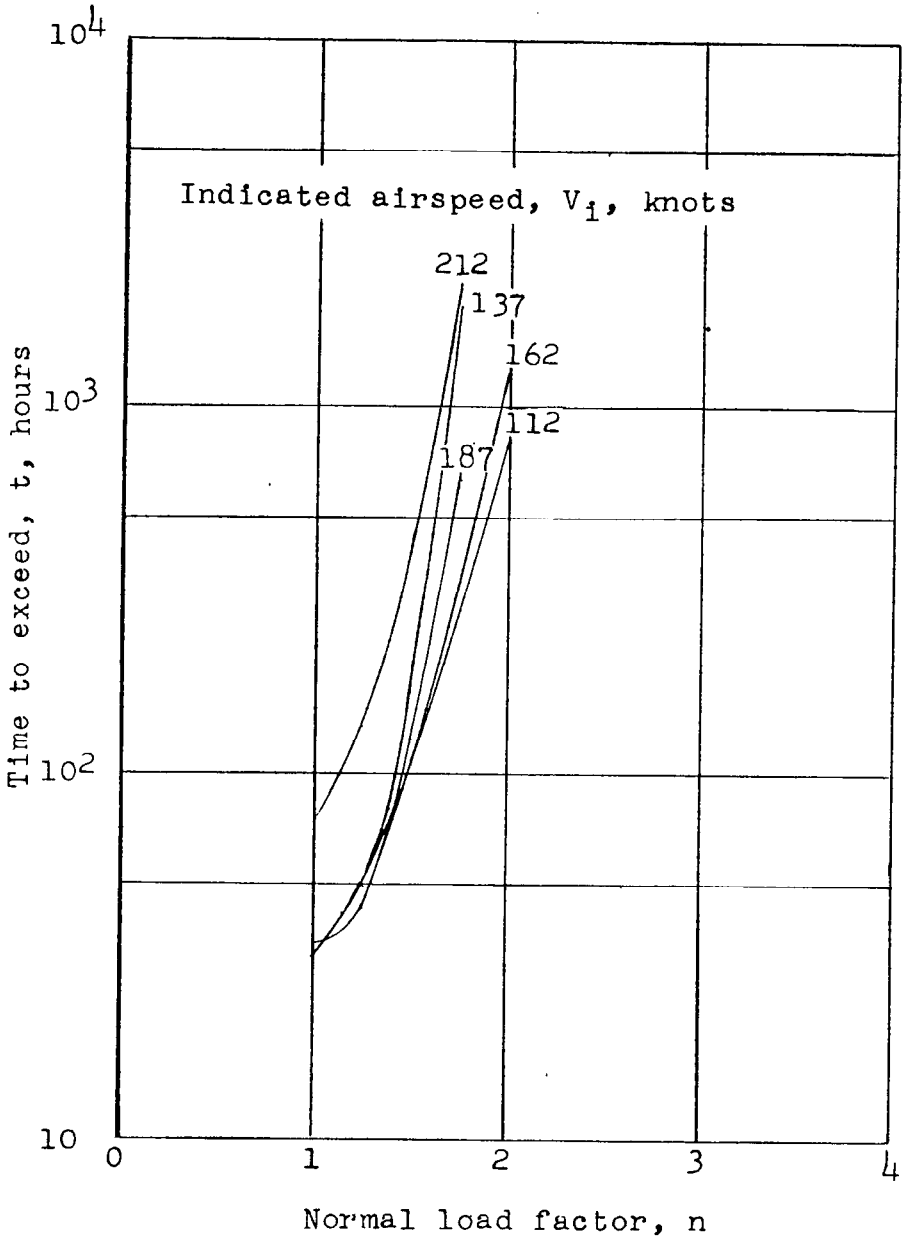

Figure 35.- Average flight time required to exceed a given load factor in a given airspeed range (based on total flight time at all speeds). Consolidated Vultee P4Y-2S airplane.

[redacted]

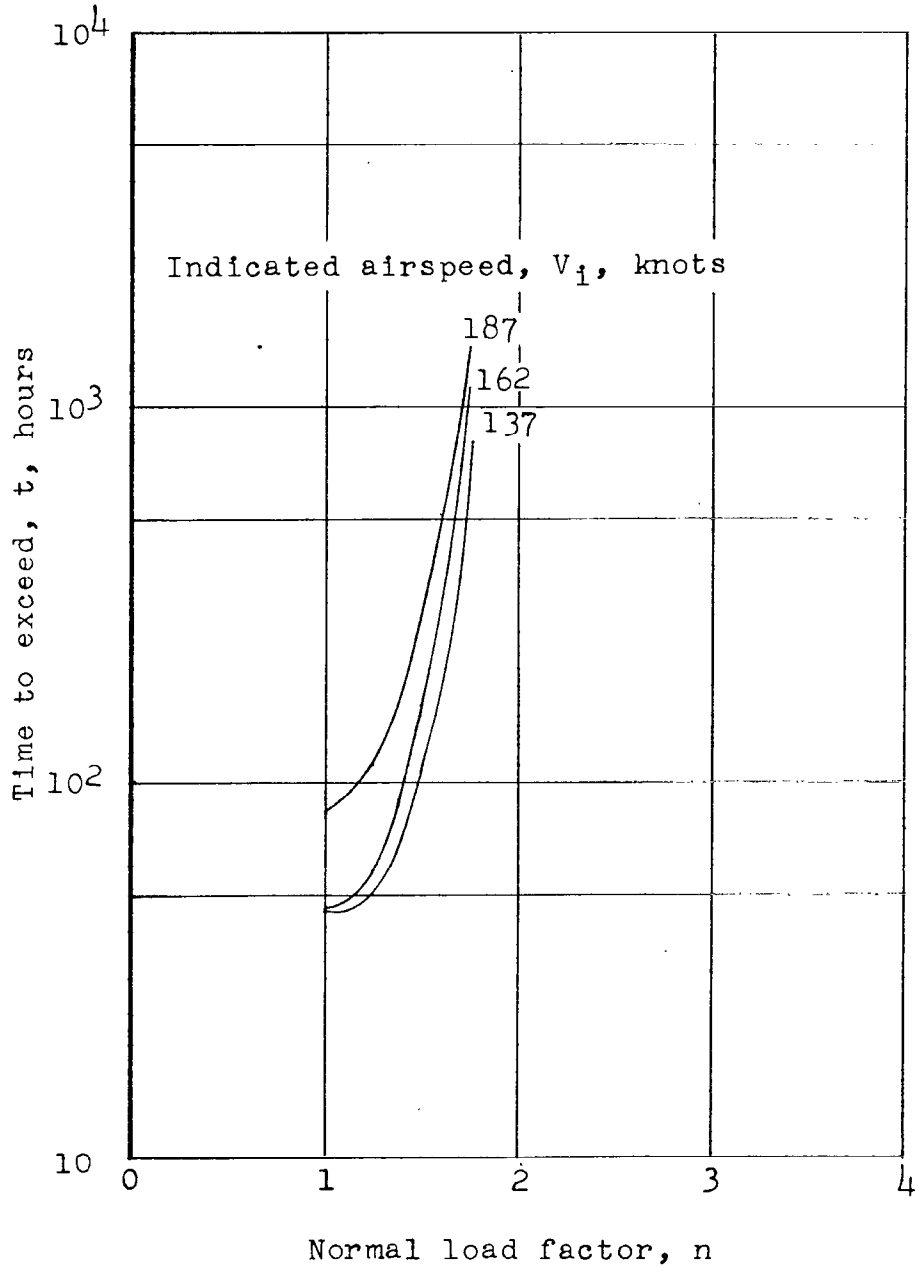

Figure 36.- Average flight time required to exceed a given load factor in a given airspeed range (based on total flight time at all speeds). Martin PBM-5S airplane.

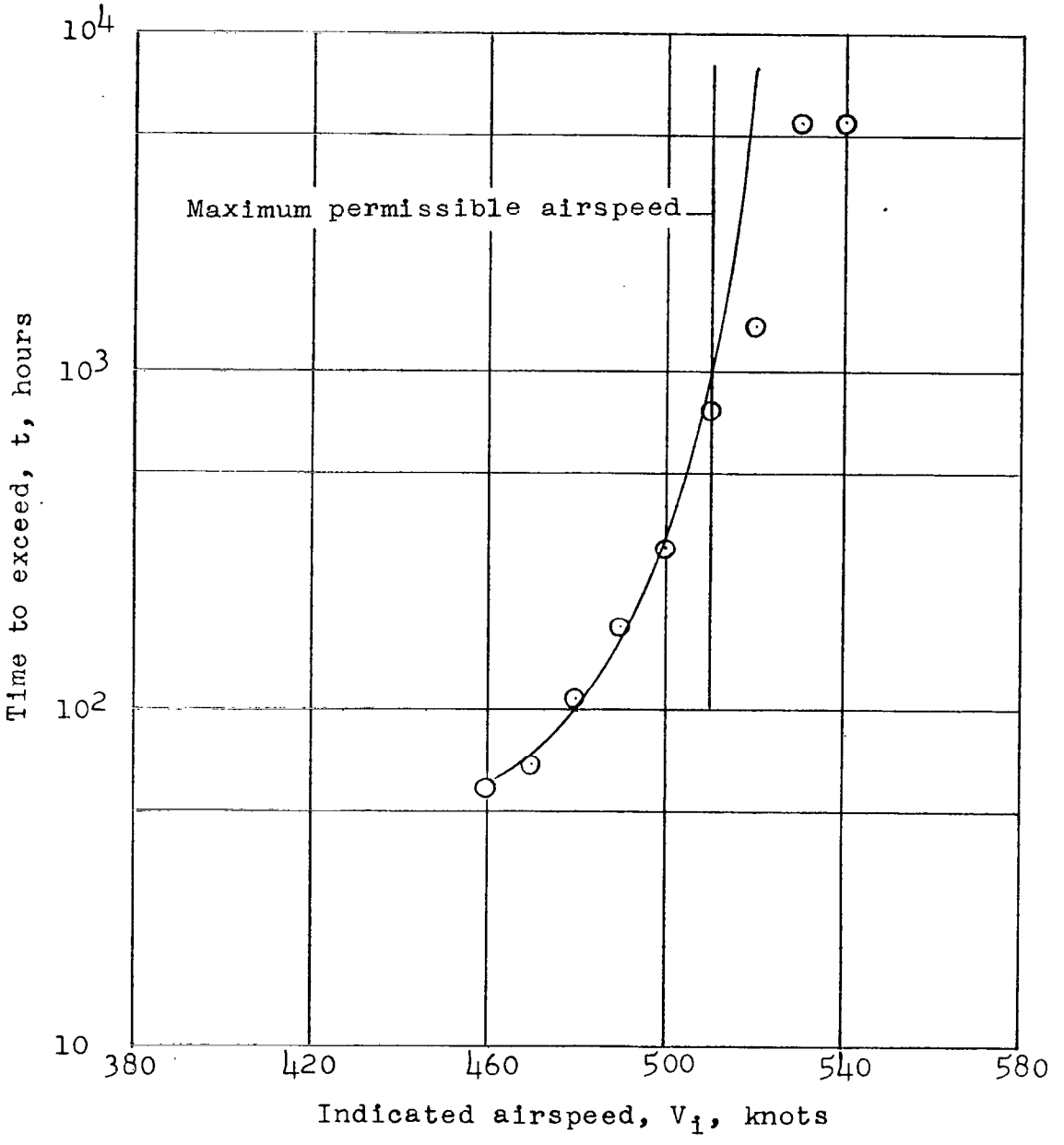

Figure 37.- Average flight time required to exceed a given indicated airspeed. McDonnell F2H-2 airplane.

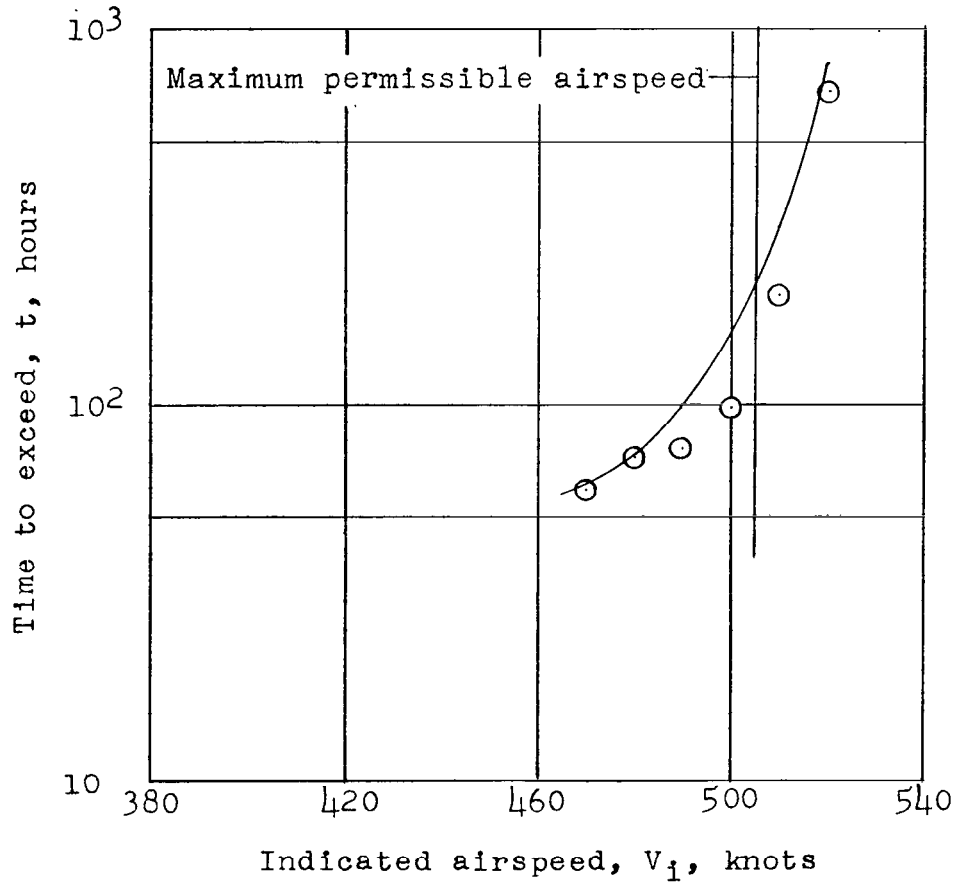

Figure 38.- Average flight time required to exceed a given indicated airspeed. Grumman F9F-2B airplane.

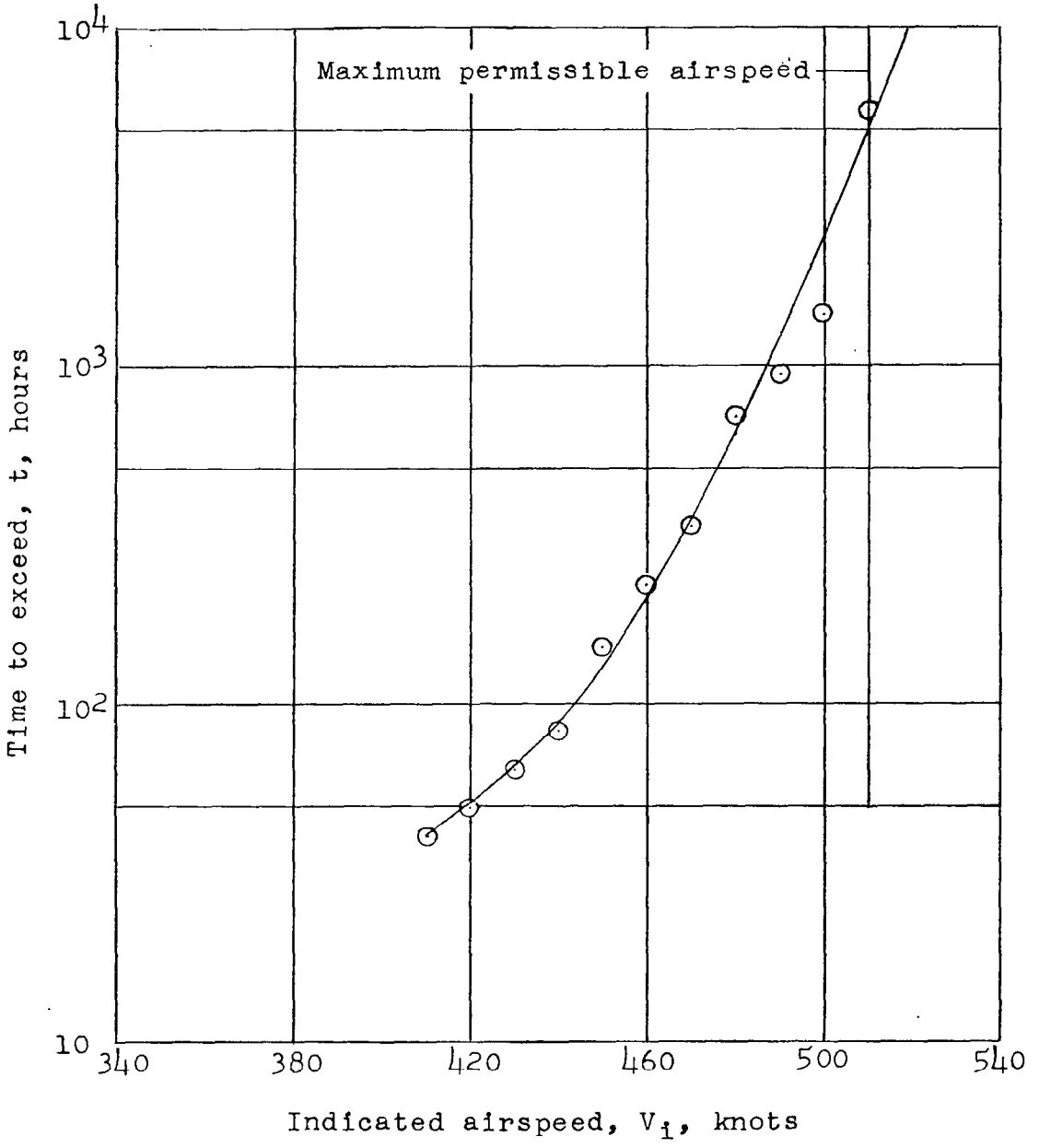

Figure 39.- Average flight time required to exceed a given indicated airspeed. Lockheed TV-1 airplane.

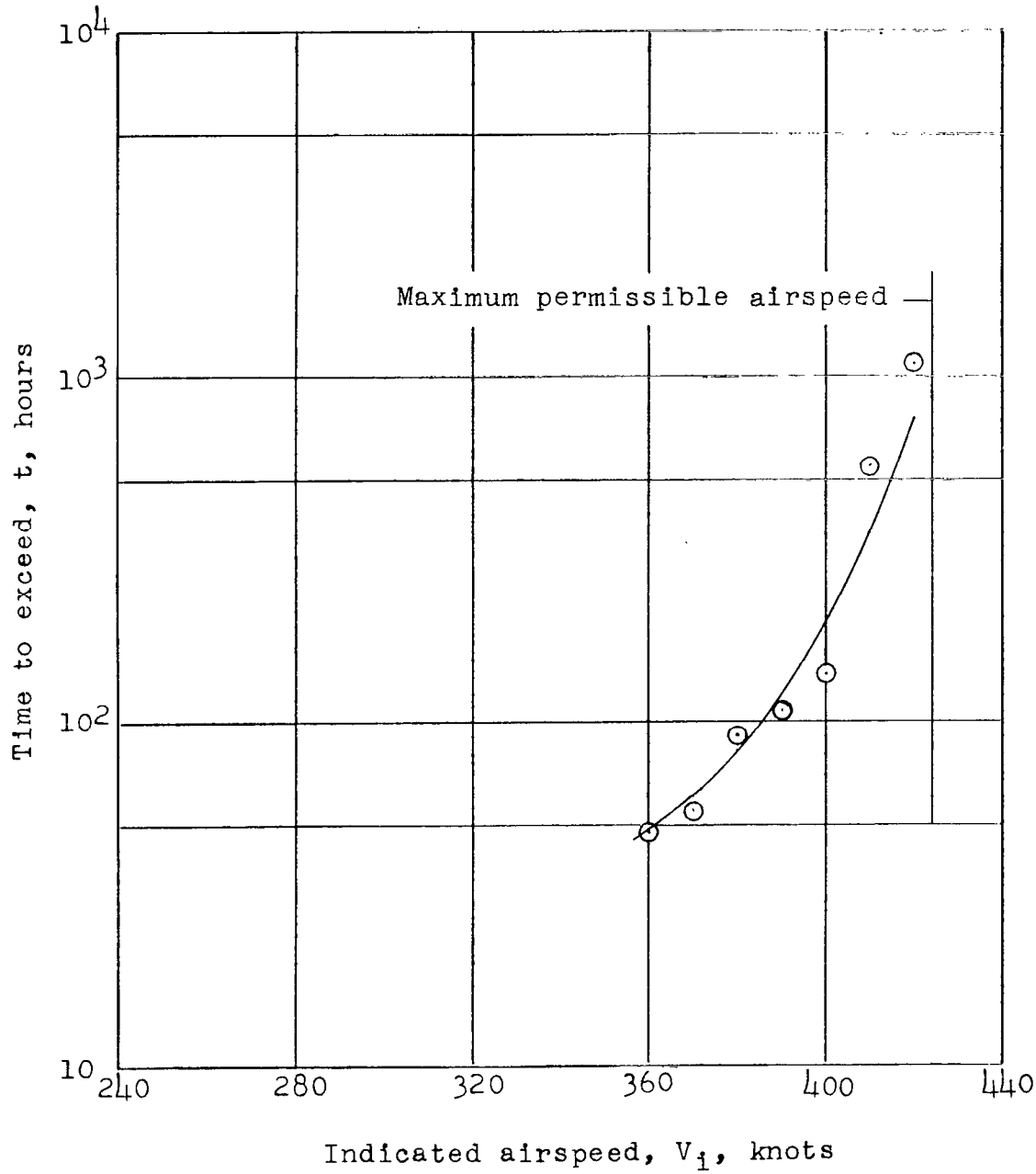

Figure 40.- Average flight time required to exceed a given indicated airspeed. Grumman F8F-2 airplane.

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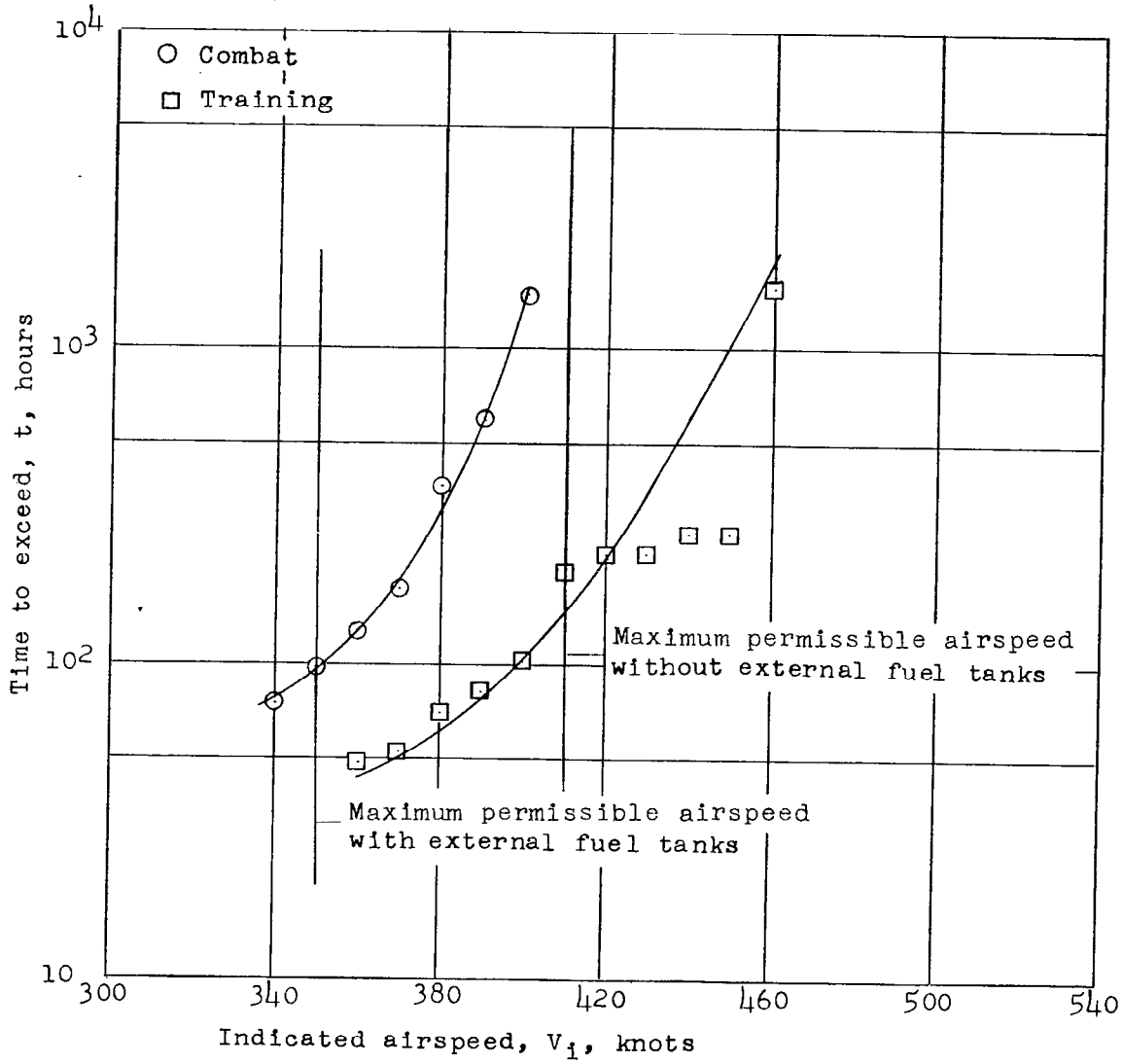

Figure 41.- Average flight time required to exceed a given indicated airspeed. Douglas AD-4 airplane.

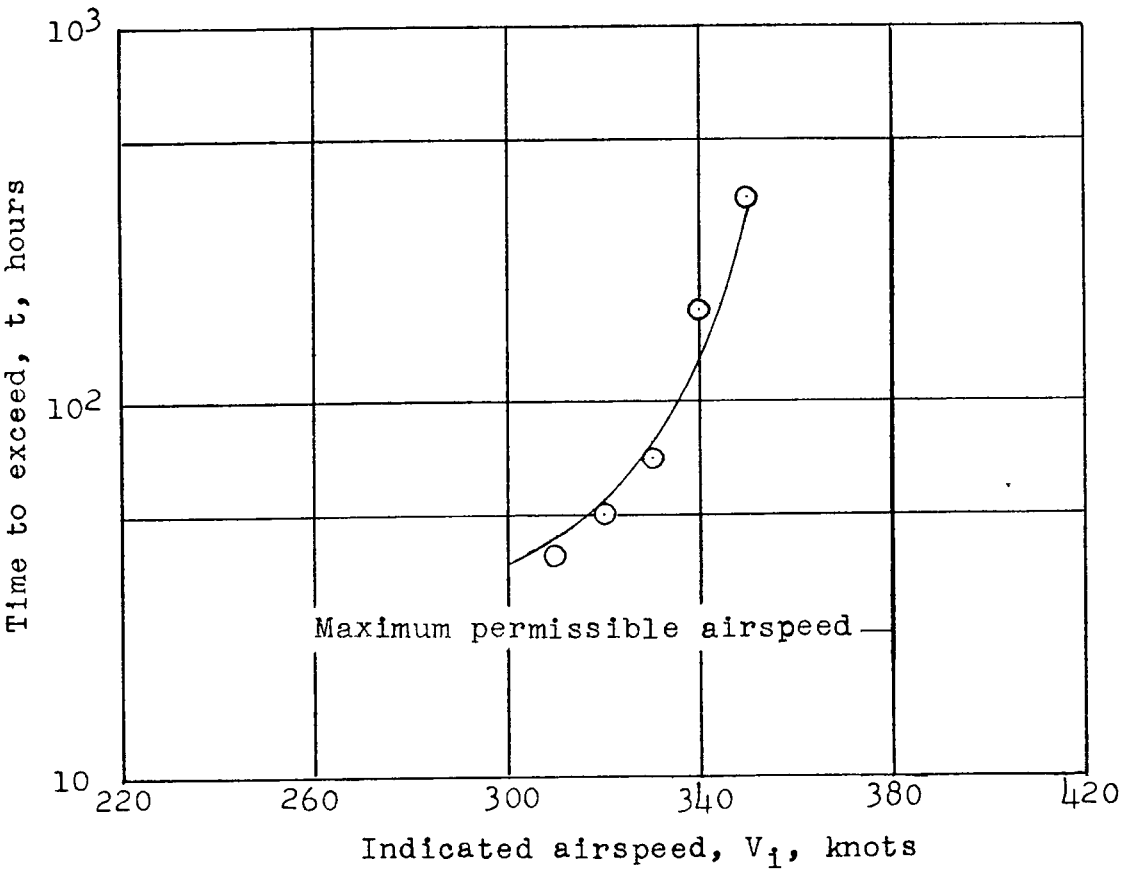

Figure 42.- Average flight time required to exceed a given indicated airspeed. North American AJ-1 airplane.

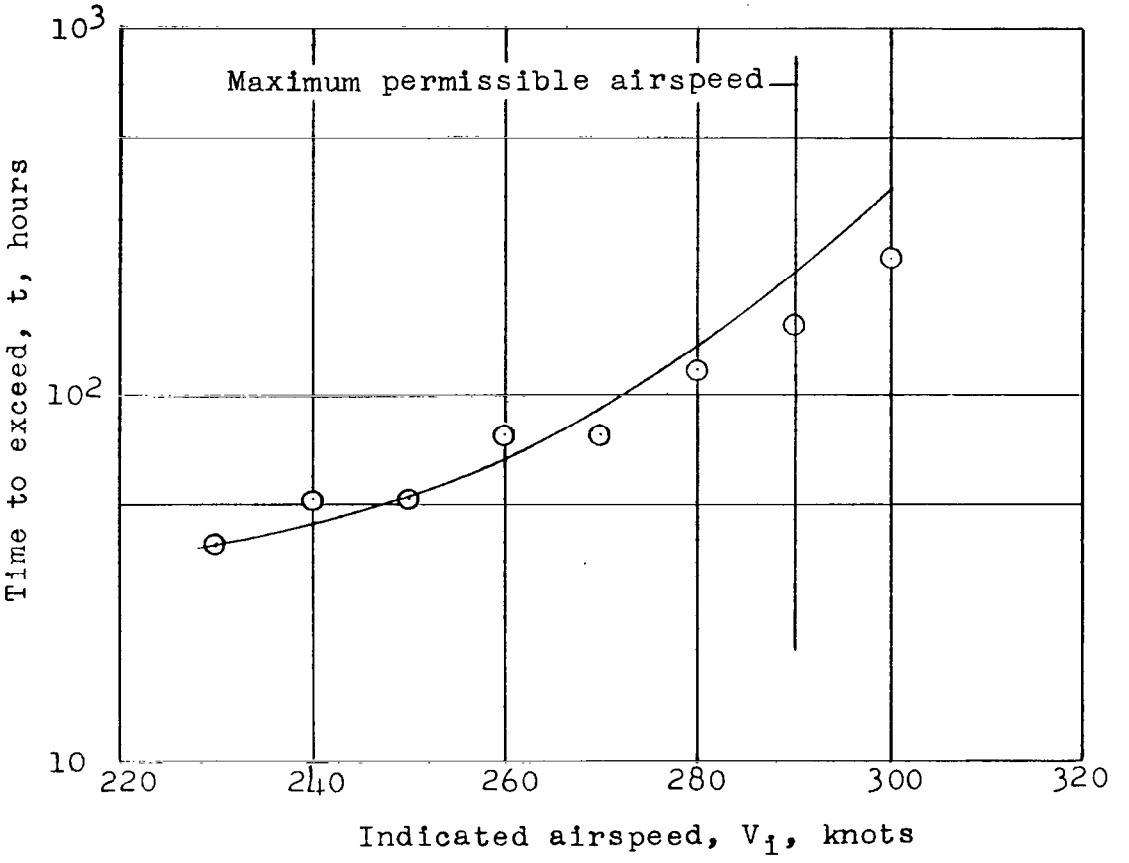

Figure 43.- Average flight time required to exceed a given indicated airspeed. Lockheed P2V-3 airplane.

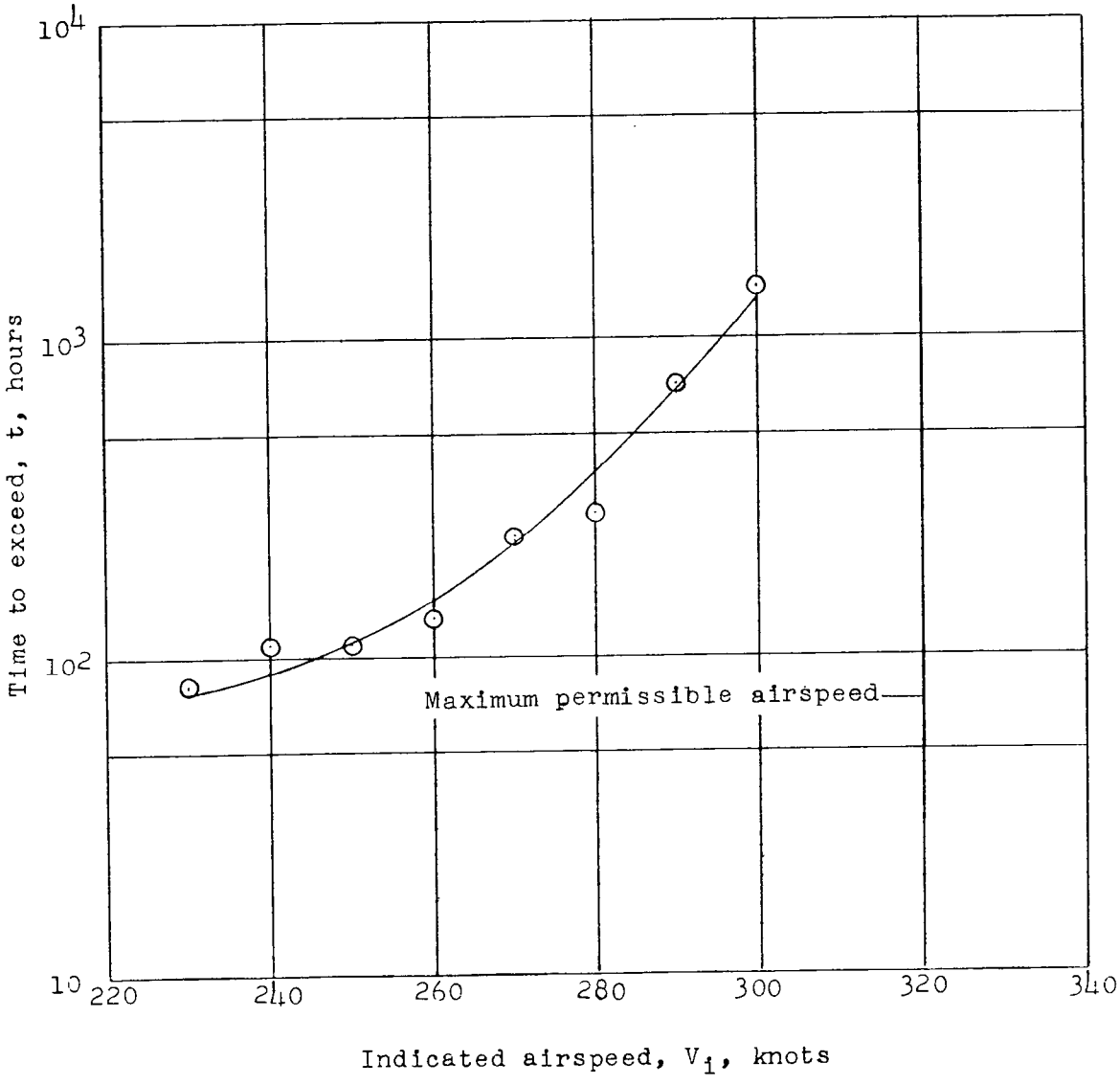

Figure 44.- Average flight time required to exceed a given indicated airspeed. Lockheed P2V-4 airplane.

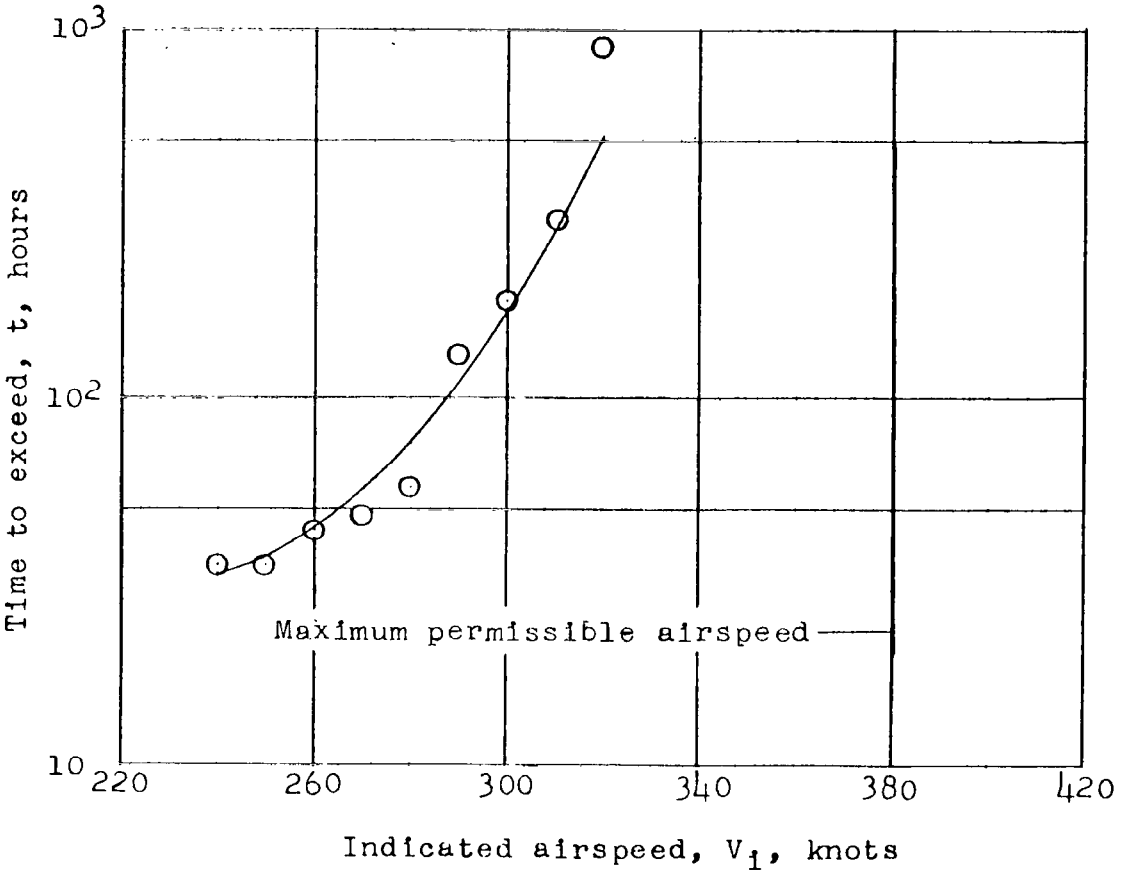

Figure 45.- Average flight time required to exceed a given indicated airspeed. Martin P4M-1 airplane.

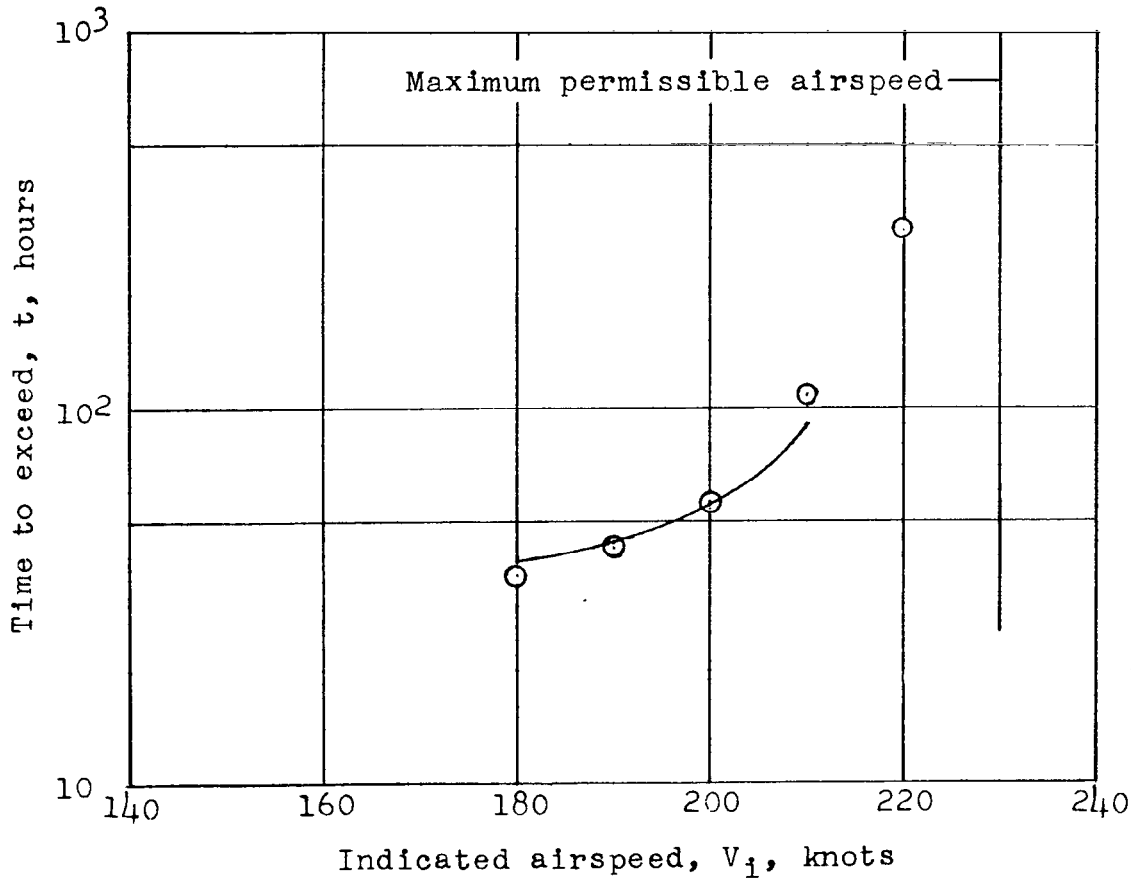

Figure 46.- Average flight time required to exceed a given indicated airspeed. Consolidated Vultee P4Y-2S airplane.

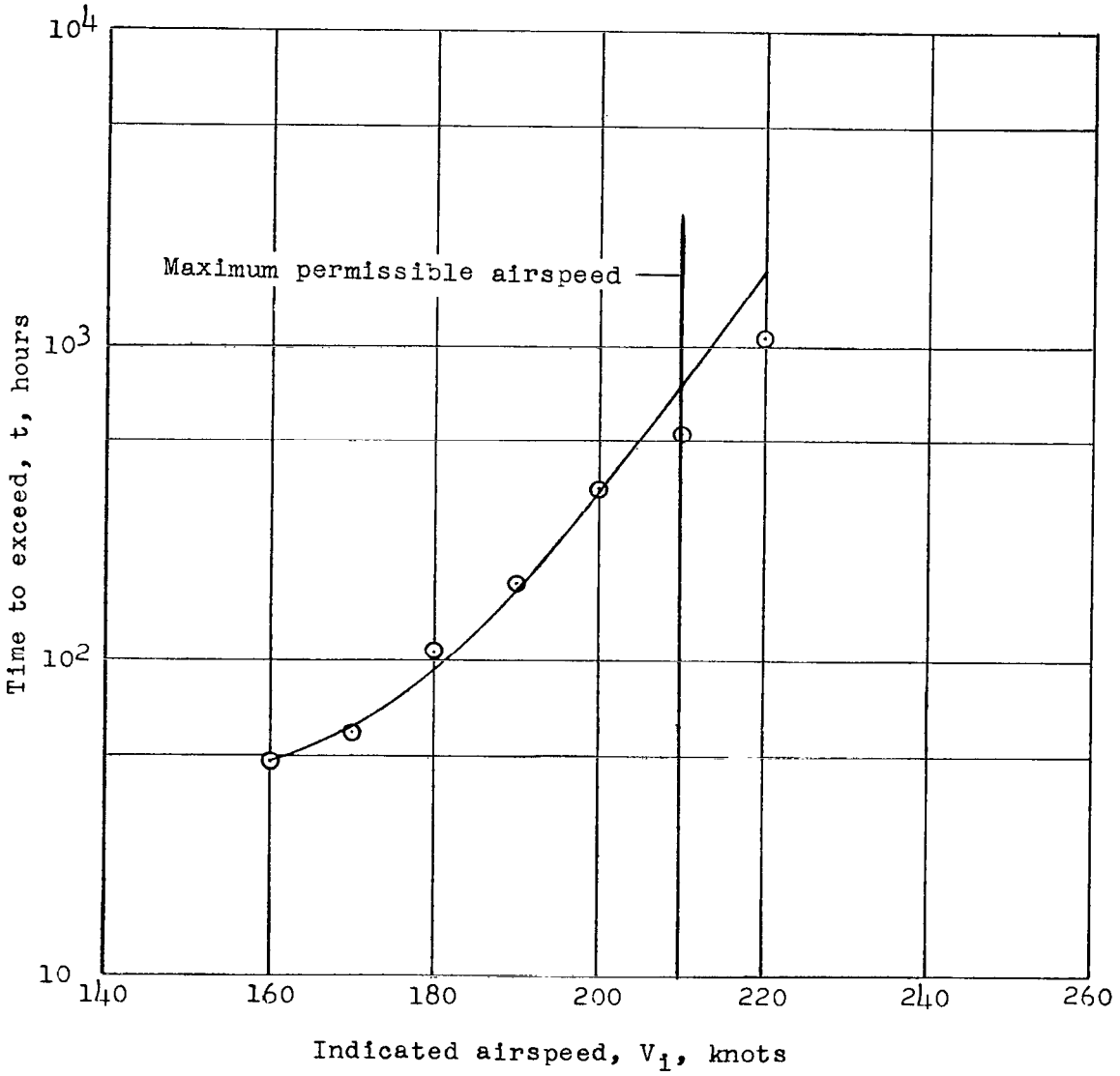

Figure 47.- Average flight time required to exceed a given indicated airspeed. Martin PBM-5S airplane.

[redacted]